REPORT OF THE

HERRING ASSESSMENT WORKING GROUP FOR THE AREA SOUTH OF 62°N

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4 CELTIC SEA AND DIVISION VIIJ HERRING

4.1 Introduction

The herring fisheries to the south of Ireland in the Celtic Sea and in Division VIIj have been considered to exploit the same stock. For the purpose of stock assessment and management these areas have been combined since 1982. The areas for which the assessments are now made, together with the area for which the TAC is set by the EU are shown in Figure 4.1.1. It should be noted that, although the management unit covers all of Divisions VIIg,h,j and k and the southern part of Division VIIa, the total Irish catch which constitutes over 95% of the catch is taken from the inshore waters along the Irish coast.

4.2 The Fishery in 1998–1999

4.2.1 Advice and management applicable to 1998 and 1999

In 1998 ACFM considered that this stock was currently well above Bpa and that the fishing mortality in 1999 should be no greater than that in 1997 (0.4). This corresponded to a catch of no more than 19,000 t. The TAC subsequently set by the EU was 21,000 t for 1999 compared with 22,200 t for 1998.

The spawning box closure system, which was first introduced in the late eighties and which is described in ICES (1989/Assess:15) was again continued during the 1998/99 season - the box closed being that in Division VIIg. This was closed for a fortnight in November 1998. The entire Irish fishery was again closed from mid-February 1998 through to early October 1998.

The total Irish quota was subdivided into boat quotas on a week by week basis. All vessels were again regulated by licences which restrict landings to specific ports and to specific times.

4.2.2 The fishery in 1998/1999

As has been the case for a number of years the major portion of the catches in this area was taken by the Irish fishery during the spawning season which normally lasts from October to February. Some small catches were taken during June 1998 as a result of an experimental fishery designed to locate shoals of "maatjes"herring.

As in recent years the main feature of the fishery during 1998/99 was the continuing poor marketing conditions which prevailed throughout the whole season. As a result the number of vessels participating in the fishery has decreased. The average number participating during the 1998/99 season was about 38 which is only about half the number which participated in the early nineties.

During the season shoals appeared to be abundant and there were reports from fishermen of very dense shoals on the spawning grounds in the Celtic Sea, particularly in January and February.

The distribution of the total international herring catches (t) in Sub-areas VI and VII per quarter per statistical rectangle, based on the logbooks and not corrected for misreporting is shown in Figures 4.2.1 a–d.

4.2.3 The catch data

The estimated national catches from 1988–1998 for the combined areas by year and by season (1 April–31 March) are given in Tables 4.2.1 and 4.2.2 respectively. The total catches for the fishery over the longer period from 1958 to 1997 are shown in Figure 4.2.2. The reported catch including some unallocated landings, taken during the 1998/1999 season was about 18,000 t compared with 20,000 t during the previous season. Some slight revisions have been made to the 1997/98 catches which had the effect of increasing the catch for that season by about 500 t.

Discards

The level of discards in this fishery is believed to have decreased considerably in recent years. In 1998/98 as a result of the poor marketing conditions there was no incentive to discard because fish suitable for the Japanese "roe" market did not command a higher market price than non "roe" fish. There were no reports of discards from the fishery in 1998/99 and no adjustments were necessary for the landings. This was in contrast to some of the years before 1997 when some landings were increased by 10%-20% to allow for discards.

4.2.4 Quality of catch and biological data

During 1997/98 and 1998/99 there has been a major increase in the monitoring of landings from this fishery and the management measures were tightly enforced throughout the season. The accuracy of the landing figures in recent years is now believed to have increased significantly.

Biological sampling of the catches throughout the area continues to be satisfactory and at a high level. Details of the sampling data per quarter are shown in Table 4.2.3, while the length distributions of the catches taken by the Irish fleet per quarter are shown in Table 4.2.4.

4.2.5 Catches in numbers at age

The total catches in numbers at age, including discards, per season from 1958 to 1998 are shown in Table 4.4.2. The age composition in 1998/99 has been dominated by 2 w.ring fish (the 1995/1996 year class). The 1993/94 year class which dominated the age composition in the two previous seasons constituted 23% of the catches in 1998/99.

4.3 Mean weights at age

As the major portion of the catch from this fishery continues to be taken during the spawning season the mean weights at age in the catches have traditionally been taken as the mean weights in the stock at spawning time (1 October). The mean weights from 1958 to 1997 are shown in Table 4.4.2. The mean weights during 1998/99 were very similar to those in recent seasons.

The mean weights (weca and west) shown in Table 4.4.2 show that a constant set of data were used for all years prior to 1984. Prior to 1982 the Celtic Sea was assessed as a single stock and it was only after 1982 that it was combined with Division VIIj for assessment and management purposes. Mean weights since 1984 have been updated each year and have been based on Irish data taken from the spawning fishery. The data set used prior to 1984 was calculated by combining data from Irish data from the Celtic Sea and Division VIIj from 1982 and this data set was then used to cover the whole period back to 1957. In the years prior to 1975 mean weights per age for the Celtic Sea were calculated from mean lengths. The 1973 Working Group which looked at growth data from the Celtic Sea commented that a very significant growth change had taken place in the stock around about 1963 and that this growth change coincided with a similar change observed in the North Sea stock. This growth change had the effect of increasing the mean weights by about 30%. Mean weights are available for all years after 1975 for the Celtic Sea and it is apparent that very big differences are present for different time periods. These are shown in the text table below.

Comparison of various mean weights, used by previous working groups and the values used by the present working group for predictions and the constant set of values used in the VPA from 1958 to 1983.

Age	1	2	3	4	5	6	7	8	9+
Pre 1964	89.9	119.3	147.4	167.2	180.2	187.0	188.8	194.5	194.5
1964 to 1973	128.4	170.4	210.6	238.9	257.4	267.0	269.7	277.8	277.8
1976	137.6	198.9	238.8	264.5	268.6	290.6	294.3	301.8	317.6
1977	139.0	195.0	229.0	259.0	270.0	288.0	295.0	299.0	317.0
1980	123.0	194.0	233.0	249.0	267.0	279.0	281.0	290.0	284.0
Mean 1993–1998	93	126	153	169	185	198	208	218	228
1957 to 1983	115.0	174.0	211.0	229.0	244.0	257.0	260.0	263.0	266.0

The data set used to study the stock recruitment relationship for this stock is based on mean weights which have constant values prior to 1984. ACFM in May 1998 commented that the part of the difficulties in selecting an appropriate Fpa for this stock is probably due to changes in weights at age.

A complete analysis of the appropriate set of mean weights at age for this stock is necessary particularly during the early time period. This should be undertaken and the results presented at the next meeting of the Working Group.

Maturity at age

The maturity at age for this stock has been assumed to be constant throughout the whole time period (50% of fish are assumed to be mature at age 1 and 100% mature at age 2). It is now apparent that the stock has undergone growth changes and also considerable changes in abundance during this time period. Both these factors may have had effects on the maturity ogive and this needs to be investigated before biological reference points are finalised.

4.4 Stock assessments

4.4.1 Acoustic surveys

A series of acoustic surveys have been carried out on this stock from 1990–1996. The series was interrupted in 1997 but has been resumed in 1998. The surveys are carried out during the spawning season which lasts from October to February/March and two surveys are carried out if possible in October and in January. The objective of the surveys is to estimate the size of the spawning stock of the autumn and winter spawning components separately. In most years it has been possible to do this with some confidence and therefore the size of both components has been combined to give the size of the total spawning stock. This estimate, broken down into numbers of fish at age, has been used in the ICA programme as a relative index of stock size. The age composition of the stock for 1998 and those obtained from previous surveys are shown in Table 4.4.1.

It was only possible to carry out one survey during the 1996/97 season and this was carried out during October. Due to severe weather conditions this survey only covered part of the survey area.

No surveys were carried out during the 1997/98 season.

During the 1998/99 season two surveys were again carried out. However, only the results of the first survey (November, 1998) were available to the Working Group.

The interruption of the time series in 1997 makes it very difficult to determine trends in spawning stock from these surveys. These difficulties are further compounded by changes which have occurred in the relative proportions of the stock components which have taken place over the time period. An examination of the relative proportions of autumn and winter spawning components show that the proportion of autumn spawners have declined consistently from 1990–1995 (Figure 4.4.1). The two most recent surveys which have been carried out in October 1996 and November 1998, have both produced high indices of spawning stock size (145,000 t and 110,000 t respectively). However, an examination of the maturity data from both these surveys indicated that over 80% of the mature stock was composed of stage IV and V fish belonging to the winter spawning component.

It is clear that the results obtained from the 1998 survey must be considered as an underestimate of the stock size for a number of reasons, viz

- The stock size is only based on the November survey and does not include the results of the February 1999 survey.
- An examination of the proportions of 1 w ring fish in the catches taken during the acoustic survey in November 1998 and catches taken in the commercial fishery during the fourth quarter (1998) and first quarter (1999) indicated that substantial numbers of fish had recruited to the fishery after the acoustic survey had been completed.
- The 1998 survey was carried out in November when most of the autumn spawners had left the area.
- The 1998 survey may not cover the entire area over which the stock was distributed as evident from the large number of high S_A values (Acoustic back scattering strength) at the outer ends of the transects, particularly south of Cork and in addition it did not extend to most of the Division VIIj.

The 1997 and 1998 Working Groups used the results of the acoustic surveys in the ICA programme but stated that the results of the 1996/97 surveys should be taken as a minimum estimate because of the fact the only one survey had been carried out and because of the restricted coverage of that survey. In 1998 the Working Group decided to use the age dissaggregated data but only over the years 2–5 as a relative index in the ICA programme. It was clear that the 1996 survey had failed to estimate the older fish in the population because of the small number of older fish recorded by the survey relative to the catch. The results of the assessment which was presented by the 1998 Working Group showed that the stock in 1997 was about 68,500 t and that the F was about 0.4.

Even with an incomplete index it was decided that the same procedure as that adopted in 1998 should again be carried out in 1999 i.e an ICA run in which the age dissaggregated data over the ages 2–5 should be used as a relative index of stock size. The input data for the ICA are shown in Table 4.4.2. An examination of the diagnostics from the ICA model showed that there was a reasonably good fit between the data and the results were therefore taken as the best indication of the state of the stock at present. The results and the diagnostics are shown in Tables 4.4.3 and in Figures 4.4.2–4.4.7.

4.4.2 Results of Assessment

The results of the assessment show that the SSB in 1998 was estimated to be around 82,000 t. The stock has increased in the early nineties due to the recruitment of the strong 1992/93 and 1993/94 year classes. Catches have been very stable for a number of years -the average catch from 1990 being 20,500 t. Fishing mortality has continued to decline since 1991 and the estimated value for 1998 = 0.32 was the lowest recorded since 1965.

4.5 Recruitment estimates

At present there are no recruitment estimates for this stock, which can be used for predictive purposes. The numbers of 1 w.ring fish estimated from the ICA suggest that a number of good year classes have recruited to the stock in recent years and that the 1992/93 and 1993/94 year classes appear to have been particularly strong.

In this stock a large proportion of juvenile fish are present in the Irish Sea and do not recruit to the Celtic Sea until they are mature. Therefore neither the numbers of 1 w.ring fish in the stock as estimated from the acoustic surveys nor the numbers in the catches give a reliable indication of year class strength. The relationship between the numbers of 1 w.ring herring taken per hour in the Northern Irish ground fish surveys and the numbers of 1. w.ring herring estimated by ICA for the Celtic Sea was examined in a working document (Armstrong *et al.*,1999, W.D) and the results suggest that these surveys may be a useful indicator of recruitment when a longer time series is established.

4.6 Short term Projection

Because of the uncertainty about the current stock size and the lack of information on recruitment it was decided that projections over a medium or long term basis would be unrealistic. A short term projection was therefore carried out under the following assumptions.:

Average recruitment based on the geometric mean level of numbers of 1 w. ring fish from 1983–1996 = 559 million compared with an estimated value of 562 million fish by the 1998 WG.

A catch in 1999 equal to 21,000 t which is the agreed TAC.

Mean weights in the stock and catch based on the average levels from 1993–1998.

Population numbers estimated at 1 January 1999 from the ICA analysis.

An SSB in 1998 of 82,500 t.

The input data used in the predictions are shown in Table 4.6.1.and the results are shown in Tables 4.6.2.-4.6.4.

If the 1999 catch is at the TAC level of 21,000 then the SSB will increase slightly to 89,315 t. If F should continue at this level (0.32) then the SSBs in 2000 and 2001 will decrease slightly to about 86,442 t and the resultant catches will be around 21,700 t in 2000.

If F is set at the F med level (0.27) in 2000 then the SSBs in 2000 and 2001 will be 88,778 t and 89,651 t. respectively and catches in 2000 would be around 18,854 t.

The SSB will start to decline slowly if F is above the present level of 0.32. An F of 0.3 would generate catches in 2000 of about 20,000 t and a spawning stock of 88,500 t in 2000 and 2001.

Plots of yield per recruit and stock and recruitment for Celtic Sea and VIIj herring are shown in Figures 4.6.1 and 4.6.2.

4.7 Biological reference points and management considerations.

Biological reference points were discussed in last year's report (ICES 1998a). There was a period of recruitment failure from around 1970 to the early 1980'ies, when recruitments were in the order of 100 million-300 million individuals, as opposed to 400 million to 1000 millions in most other years. This recruitment failure apparently was not induced by a low SSB. Rather, it started when the SSB was at a high level and recruitment returned to normal while the SSB was at its lowest. Overall, the recruitment does not appear to be strongly dependent on the SSB.

In the periods with good recruitment, the fishing mortalities have mostly been in the range 0.35 - 0.6, and the stock seems to have tolerated this fishing mortality well. This fishing mortality is higher than that which most herring stocks will tolerate. The background for this may be partly because the recruits per SSB is quite high, except in the period with poor recruitment, and partly because the fishery is almost exclusively on mature fish, which gives a favourable SSB per recruit.

Last years Working Group suggested a B_{lim} at 26,000 tonnes, which is the lowest SSB observed and is just below the biomass level which gave rise to the first strong year classes after the collapse. Assuming a 30% CV on the current SSB estimates leads to a B_{pa} of 40,000 t.

In order to evaluate long-term risk associated recruitment variation at various exploitation levels, long term stochastic equilibiria were computed for periods with good and poor recruitment separately. In both cases, the recruitment was assumed to be independent of the SSB for SSB> 26,000 tonnes, and declining linearly to 0 with declining SSB below that value. The recruitment was assumed to vary randomly as $Ry = R0*\exp(\varepsilon)$, where ε was drawn as random numbers with normal distribution with mean = 0 and variance σ^2, truncated at ±1.0 The standard R_0 and σ were found as the geometric mean and log variance of recruitments either above or below 300 millions, giving R0 = 636 and 195, and s = 0.37 and 0.27 respectively. No other sources of uncertainty were included. The simulation software was the same as used for North Sea herring (Patterson *et al* 1997b, ICES 1996a). The results are shown in Figures 4.7.1 and 4.7.2.

With good recruitment, the risk of SSB< 26,000 tonnes was negligible for the whole range of F-values up to 0.8, which was the highest value tested. The risk of SSB < 40,000 tonnes started to increase at F = 0.6, and had reached 7.4% at F = 0.8. The median catch was 20,000 tonnes at just below F = 0.2 and reached 23,000 tonnes at F = 0.8, without any clear maximum.

With a poor recruitment, the risk of SSB < 40,000 tonnes started to increase at F = 0.12 and passed 50% at F = 0.19. The risk of SSB < 25.000 tonnes started to increase at F = 0.2 and passed 50% at F = 0.37. The F giving the maximum median long term yield was poorly defined at about 0.3 during a period of sustained low recruitment.

Medium term simulations with stochastic recruitment as described above, indicated that if a poor recruitment period started in 1999, it would take 4–5 years for the SSB to fall below 40,000 tonnes and 7–8 years to fall below 26,000 tonnes with a constant F of 0.4. With a constant F of 0.27, which is equivalent to F med as defined by ACFM in May 1998 it would take 5–6 years to fall below 40,000 tonnes, and the probability of reaching 26,000 tonnes in the 10 years simulation period was below 1%. Some results of the simulation is tabulated below (Tables 4.7.1 and 4.7.2). This medium term simulation software was also used for North Sea herring (ICES 1996a).

Because of the recruitment pattern described above, the biomass reference points lead to different management advice for the periods with good and poor recruitment. In periods with good recruitment, the previously suggested Fpa of 0.4 seems adequate also according to the present study, and the fishery has been conduced with such F-values for long periods without any systematic trends in the SSB. In periods with low recruitment this mortality (0.4) is obviously too high. According to the present simulations, the Fpa in during periods of low recruitment should be below 0.2.

Several factors are known that will influence these considerations, which have not been taken into account here. As noted in Section 4.3 large variations in weight at age have occurred in previous years, but these have not been investigated in recent years. Likewise, variations in the maturity at age have not been taken into account. Variations in these parameters will broaden the distributions of yield and SSB, and induce less steep risk profiles, in addition to altering the SSB-recruit data.

Furthermore, if an F-value around 0.4 is to be applied, there is a risk of severely decreasing the stock before a period of poor recruitment is recognised, and this should be taken into account. At present, tools are not available to simulate this taking into account all aspects of uncertainty. It should also be noted that even though an F of 0.4 apparently carries a low risk, there is not much to gain in terms of long term yield by increasing F beyond 0.3.

The Working Group reconsidered the fishing mortality reference point, Fpa which ACFM suggested should be set at 0.27, based on F med. Since it appears that this stock experiences periods of high and periods of low recruitment, irrespective of spawning stock biomass, the Working Group was of the opinion that F med. may not be an appropriate basis for Fpa. The Working Group also considered that the historic fishing mortality has been below 0.3 in only four years out of 41 (1961,1963,1964, and 1965) and yet the stock appears to be in a healthy state. Results from the simulations show that there is not much difference in the probabilities of falling below Bpa, and the expected SSB, between F = 0.27 and F = 0.3. This is the case for scenarios for low and high recruitment. For F> 0.3, the risk to the stock (in terms of P(SSB< Bpa)) increases, particularly when recruitment is low, and there is not much to be gained in terms of expected yield. The Working Group therefore proposes Fpa = 0.3 for this stock. An Fpa of 0.3 would not cause unnecessary restrictions in catches at present as we are in a period of good recruitment. In addition it would provide sufficient time to detect a sustained period of poor recruitment and therefore allow managers to take appropriate action. This value would not, however, be valid during a period of low recruitment. If recruitment returns to sustained low level then the Fpa should not exceed 0.2.

4.8 Management considerations

The most recent assessment must be considered a conservative one in which the SSB is underestimated for various reasons. The SSB is, however, currently estimated to be at a high level, catches have been stable in recent years and the Fs have decreased to a low level for this stock. Because of the uncertainties that surround recruitment estimates and the lack of any indicator that might predict a return to a low recruitment era, it would be inadvisable to allow catches to increase above 20,000 t. A catch of 20,000 t is consistent with an F of 0.3 and a Bpa of above 40,000 t. The present situation in the fishery in which markets are depressed and fishing effort has decreased means that an opportunity now exists to allow the stock to increase and at the same time to effect an improvement in the age composition of the stock. If this were achieved it would mean that the stock would be in a better position to withstand a reduced recruitment period if it should come about and a consequential severe reduction in catches.

Protection of Spawning Grounds

The main Irish fishery takes place on the spawning grounds along the Irish coast. The spawning grounds are well known and are mainly located in shallow inshore waters. In recent years a number of these spawning grounds have come under threat from possible extraction of gravel, dumping of harbour silt and dredge spoil and from the sighting of fish farms. It is extremely important for the survival of the stock that these spawning grounds are adequately protected.

Table 4.2.1 Celtic Sea and Division VIIj herring landings by calendar year (t), 1988–1998. (Data provided by Working Group members.)

These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1988	-	-	16,800	-	-	-	2,400	19,200
1989	+	-	16,000	1,900	-	1,300	3,500	22,700
1990	+	-	15,800	1,000	200	700	2,500	20,200
1991	+	100	19,400	1,600	-	600	1,900	23,600
1992	500	-	18,000	100	+	2,300	2,100	23,000
1993	-	-	19,000	1,300	+	-1,100	1,900	21,100
1994	+	200	17,400	1,300	+	-1,500	1,700	19,100
1995	200	200	18,000	100	+	-200	700	19,000
1996	1,000	0	18,600	1,000	-	-1,800	3,000	21,800
1997	1,300	0	18,000	1,400	-	-2,600	700	18,800
1998	+	-	19,300	1,200	-	-200	0	20,300[1]

[1] Preliminary

Table 4.2.2 Celtic Sea and Division VIIj herring landings (t) by season (1 April–31 March) 1988/1989-1998/1999. (Data provided by Working Group members. 1998/99 figures are preliminary.).
These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1988/1989	-	-	17,000	-	-	-	3,400	20,400
1989/1990	+	-	15,000	1,900	-	2,600	3,600	23,100
1990/1991	+	-	15,000	1,000	200	700	1,700	18,600
1991/1992	500	100	21,400	1,600	-	-100	2,100	25,600
1992/1993	-	-	18,000	1,300	-	-100	2,000	21,200
1993/1994	-	-	16,600	1,300	+	-1,100	1,800	18,600
1994/1995	+	200	17,400	1,300	+	-1,500	1,900	19,300
1995/1996	200	200	20,000	100	+	-200	3,000	23,300
1996/1997	1,000	-	17,900	1,000	-	-1,800	750	18,800
1997/1998	1,300	-	19,900	1,400	-	-2100	0	20,500
1998/1999[1]	+	-	17,700	1,200	-	-700	-	18,200

[1] Preliminary

Table 4.2.3 Celtic Sea, Division VIIj (1998–1999). Sampling intensity of commercial catches.

Country		Catch (t)	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t	Estimates of discards
Ireland	Q 4	9,689	33	1606	6723	165	No
	Q 1	8,025	14	691	4199	86	No
Netherlands	Q3	1,206	0				
France	Q3	+	0	-	-	-	-

Table 4.2.4 Celtic Sea and Division VIIj. Length distribution of Irish catches/quarter (thousands) 1998/99.

Length	Q2 98	Q4 98			Q1 99		
	VIIaS VIIg&j	VIIaS	VIIj	VIIg	VIIaS	VIIj	VIIg
18	13.71						
	32.53						
19	67.51						
	77.38						
20	168.72	5.99			33.63		
	181.6	23.95	18.15	13.43			25.43
21	365.22	113.76	24.2	40.29	156.96		
	395.91	161.65	30.25	107.45	190.59		50.86
22	677.8	299.36	54.45	174.6	470.88		76.29
	599.17	365.22	96.8	308.92	773.59	10.45	356.04
23	874.87	736.43	133.1	980.47	2208.64	20.91	737.5
	605.76	700.5	242.01	1074.49	1984.42	26.13	686.64
24	813.19	963.94	496.12	2337.31	3475.53	109.76	1322.42
	526.7	419.11	592.92	2081.82	2713.16	36.59	661.21
25	928.68	886.11	1155.59	3398.07	3867.93	277.02	1144.4
	697.83	664.58	1185.84	2739.95	2040.47	162.03	788.37
26	865.61	922.03	1869.52	5493.32	3587.65	381.56	2543.12
	451.41	640.63	1972.37	5439.6	3094.35	313.61	3865.54
27	266.32	646.62	2032.87	7440.84	4159.43	339.74	4871.07
	93.35	281.4	1107.19	3975.61	2108.05	125.44	1932.77
28	49.51	269.42	1089.04	2753.38	1648.07	52.27	1475.01
	19.99	113.76	490.07	1141.64	616.63	15.68	483.19
29	23.25	47.9	592.92	980.47	369.98	41.81	279.74
	2.09	11.97	326.71	201.47	78.48	5.23	101.72
30		5.99	193.61	147.74	33.63	10.45	25.43
			139.15	53.72			
31			18.15		11.21		
			12.1				
32							
Total	8 798	8 280	13 873	40 885	33 623	1 929	21 427

Table 4.4.1 Total stock numbers at age (10^6) estimated using combined acoustic surveys estimates from November and January.

W.Rs	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996*	1998*
0	204.8	213.8	141.8	258.8	41.3	5.1	2.8	-
1	131.6	62.6	426.9	217.1	38.0	279.5	133.6	21.43
2	249.0	195.2	117.0	437.9	127.2	550.7	757.0	157.13
3	108.6	94.7	87.8	58.7	160.3	138.4	249.9	149.62
4	152.5	54.0	49.6	63.4	10.5	93.5	50.6	201.48
5	32.4	84.8	22.2	26.0	10.6	7.9	41.9	108.53
6	14.9	22.1	24.2	16.3	6.5	9.2	1.1	31.71
7	6.1	5.3	9.6	24.6	1.6	8.4	14.2	29.80
8	2.5	6.1	1.8	2.3	2.6	9.2	0.5	3.95
9+	1.5	-	1.1	1.7	0.5	4.7	1.8	1.28
Total	903.9	738.6	882.0	1,106.8	399.1	1106.5	1,253.4	704.9
TSB (000't)	103.0	84.4	88.5	104.0	51.8	134.6	151.3	110.9
SSB (000't)	91.0	77.0	71.0	90.0	50.6	114.0	145.8	110.5

* November survey only, likely to be an underestimate of stock size.

Table 4.4.2 Herring in the Celtic Sea & VIIj

Herring Celtic VIIj (**run: ICACJK07/I07**)
Output Generated by ICA Version 1.4
Catch in Number x 10 ^ 6

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	1.64	1.20	2.84	2.13	.77	.30	7.53	.06
2	3.74	25.72	72.25	16.06	18.57	51.94	15.06	70.25
3	33.09	2.27	24.66	32.04	19.91	13.03	17.25	9.37
4	25.75	19.26	3.78	5.63	48.06	4.18	6.66	15.76
5	12.55	11.02	13.70	2.03	8.08	20.69	1.72	3.40
6	23.95	5.83	4.43	5.07	3.58	2.69	8.72	4.54
7	16.09	17.82	6.10	2.83	8.59	1.39	1.30	12.13
8	9.38	3.75	4.38	1.52	3.81	2.49	.58	1.38
9	5.58	7.35	4.15	4.95	5.32	2.79	2.19	7.49

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	7.09	7.60	12.20	9.47	1.32	12.66	8.42	23.55
2	19.56	39.99	54.79	93.28	37.26	23.31	137.69	38.13
3	59.89	20.06	39.60	55.04	50.09	37.56	17.86	55.81
4	9.92	49.11	11.54	33.15	26.48	41.90	15.84	7.01
5	13.21	9.22	22.60	12.22	18.76	18.76	14.53	9.65
6	5.60	9.44	4.93	17.84	7.85	10.44	4.64	5.32
7	3.59	3.94	4.17	4.76	6.35	4.28	3.01	3.35
8	8.75	6.51	1.31	2.17	2.18	4.94	2.37	2.33
9	3.84	6.76	4.94	3.47	3.37	2.24	1.02	1.21

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	5.51	12.77	13.32	8.16	2.80	11.34	7.16	39.36
2	42.81	15.43	11.11	12.52	13.39	13.91	30.09	21.29
3	17.18	17.78	7.29	8.61	11.95	12.40	11.73	21.86
4	22.53	7.33	7.01	5.28	5.58	8.64	6.59	5.51
5	4.23	9.01	2.87	1.59	1.58	2.89	2.81	4.44
6	3.74	3.52	4.79	1.90	1.48	1.32	2.20	3.44
7	2.98	1.64	1.98	1.04	.54	1.28	1.18	.80
8	.90	1.14	1.24	.38	.86	.55	1.26	.31
9	.83	1.19	1.77	.47	.48	.64	.56	.87

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	15.34	13.54	19.52	17.92	4.16	5.98	2.31	8.26
2	42.73	102.87	92.89	57.05	56.75	67.00	82.03	42.41
3	8.73	26.99	41.12	36.26	42.88	43.08	30.96	68.40
4	4.82	3.23	16.04	16.03	32.93	23.01	9.40	19.60
5	1.50	1.86	2.45	2.31	8.79	14.32	5.96	8.21
6	1.89	.33	1.09	.23	1.13	2.72	3.05	3.84
7	1.67	.37	.38	.09	.10	1.18	.87	2.59
8	.34	.93	.23	.17	.03	.30	.30	.77
9	.60	.31	.18	.13	.01	.46	.09	.68

Catch in Number x 10 ^ 6

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	2.70	1.91	10.41	1.61	12.13	9.45	3.48	3.85
2	41.76	63.85	26.75	94.06	35.77	79.16	61.92	37.44
3	24.63	38.34	35.02	9.37	61.74	22.59	38.24	53.04
4	35.26	16.92	27.59	10.22	3.29	36.54	7.94	31.44
5	8.12	28.41	10.14	4.49	3.03	3.69	16.11	8.32
6	3.81	4.87	18.06	2.79	4.77	3.42	2.08	6.14
7	1.67	2.59	3.02	5.93	1.71	2.65	1.59	1.15
8	.69	.95	6.29	.86	1.71	1.86	1.51	.83
9	.46	.59	.69	.51	.47	.84	1.03	.60

Table 4.4.2 ctd.

AGE	1998
1	5.86
2	41.97
3	27.32
4	28.58
5	13.31
6	3.79
7	2.70
8	.60
9	.39

Predicted Catch in Number x 10 ^ 3

AGE	1993	1994	1995	1996	1997	1998
1	3173.	7084.	9549.	3521.	3261.	5857.
2	75120.	31440.	99156.	82207.	41223.	32457.
3	9708.	43047.	25837.	48270.	57418.	24490.
4	8499.	4604.	29464.	10344.	28123.	28421.
5	6666.	4038.	3167.	11826.	6031.	13902.
6	3548.	3784.	3297.	1524.	8208.	3558.
7	4313.	1789.	2755.	1405.	942.	4310.
8	855.	2345.	1399.	1267.	936.	534.

Weights at age in the catches (Kg)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500
2	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400
3	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100
4	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900
5	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400
6	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700
7	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300
9	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500
2	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400
3	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100
4	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900
5	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400
6	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700
7	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300
9	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500
2	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400
3	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100
4	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900
5	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400
6	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700
7	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300
9	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600

Table 4.4.2 ctd.

Weights at age in the catches (Kg)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	.11500	.11500	.09300	.10400	.11200	.09600	.09700	.10600
2	.17400	.17400	.14200	.14000	.15500	.13800	.13200	.12900
3	.21100	.21100	.18500	.17000	.17200	.18600	.16800	.15100
4	.22900	.22900	.21300	.20100	.18700	.19200	.20300	.16900
5	.24400	.24400	.21300	.23400	.21500	.20400	.20900	.19400
6	.25700	.25700	.24500	.24800	.24800	.23100	.21500	.19900
7	.26000	.26000	.24600	.25600	.27600	.25500	.23700	.21000
8	.26300	.26300	.26300	.26000	.28400	.26700	.25700	.22100
9	.26600	.26600	.26200	.26300	.33200	.28400	.28300	.24000

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	.09900	.09200	.09600	.09200	.09700	.08800	.08800	.09300
2	.13700	.12800	.12300	.12900	.13500	.12600	.11800	.12400
3	.15300	.16800	.15000	.15500	.16800	.15100	.14700	.14100
4	.16700	.18200	.17700	.18000	.17900	.17800	.15900	.15700
5	.18800	.19000	.19100	.20100	.19000	.18800	.18500	.17200
6	.20800	.20600	.19400	.20400	.21000	.19800	.19600	.19200
7	.20900	.22900	.21200	.21000	.21800	.20700	.20700	.20600
8	.22900	.23600	.22800	.22500	.21700	.22700	.21900	.21600
9	.25100	.25100	.24800	.24000	.22700	.22700	.23100	.22000

AGE	1998
1	.09900
2	.12100
3	.15300
4	.16300
5	.17300
6	.18500
7	.19900
8	.20400
9	.22500

Weights at age in the stock (Kg)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500
2	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400
3	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100
4	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900
5	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400
6	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700
7	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300
9	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500
2	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400
3	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100
4	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900
5	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400
6	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700
7	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300
9	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600

Table 4.4.2 ctd.

Weights at age in the stock (Kg)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500
2	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400
3	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100
4	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900
5	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400
6	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700
7	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300
9	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	.11500	.11500	.09300	.10400	.11200	.09600	.09700	.10600
2	.17400	.17400	.14200	.14000	.15500	.13800	.13200	.12900
3	.21100	.21100	.18500	.17000	.17200	.18600	.16800	.15100
4	.22900	.22900	.21300	.20100	.18700	.19200	.20300	.16900
5	.24400	.24400	.21300	.23400	.21500	.20400	.20900	.19400
6	.25700	.25700	.24500	.24800	.24800	.23100	.21500	.19900
7	.26000	.26000	.24600	.25600	.27600	.25500	.23700	.21000
8	.26300	.26300	.26300	.26000	.28400	.26700	.25700	.22100
9	.26600	.26600	.26200	.26300	.33200	.28400	.28300	.24000

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	.09900	.09200	.09600	.09200	.09700	.08800	.08800	.09300
2	.13700	.12800	.12300	.12900	.13500	.12600	.11800	.12400
3	.15300	.16800	.15000	.15500	.16800	.15100	.14700	.14100
4	.16700	.18200	.17700	.18000	.17900	.17800	.15900	.15700
5	.18800	.19000	.19100	.20100	.19000	.18800	.18500	.17200
6	.20800	.20600	.19400	.20400	.21000	.19800	.19600	.19200
7	.20900	.22900	.21200	.21000	.21800	.20700	.20700	.20600
8	.22900	.23600	.22800	.22500	.21700	.22700	.21900	.21600
9	.25100	.25100	.24800	.24000	.22700	.22700	.23100	.22000

AGE	1998
1	.09900
2	.12100
3	.15300
4	.16300
5	.17300
6	.18500
7	.19900
8	.20400
9	.22500

Natural Mortality (per year)

AGE	1958	1959	1960	etc	1996	1997	1998
1	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000
2	.3000	.3000	.3000	fixed	.3000	.3000	.3000
3	.2000	.2000	.2000	fixed	.2000	.2000	.2000
4	.1000	.1000	.1000	fixed	.1000	.1000	.1000
5	.1000	.1000	.1000	fixed	.1000	.1000	.1000
6	.1000	.1000	.1000	fixed	.1000	.1000	.1000
7	.1000	.1000	.1000	fixed	.1000	.1000	.1000
8	.1000	.1000	.1000	fixed	.1000	.1000	.1000
9	.1000	.1000	.1000	fixed	.1000	.1000	.1000

Table 4.4.2 ctd.
Proportion of fish spawning

AGE	1958	1959	1960	etc	1996	1997	1998
1	.5000	.5000	.5000	fixed	.5000	.5000	.5000
2	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000

Table 4.4.3
AGE-STRUCTURED INDICES FLT02: celtic combined acc data (Catch:

AGE	1990	1991	1992	1993	1994	1995	1996	1997
2	249.00	195.20	117.00	437.90	127.20	550.70	757.00	*******
3	108.60	94.70	87.80	58.70	160.30	138.40	249.90	*******
4	152.50	54.00	49.60	63.40	10.50	93.50	50.60	*******
5	32.40	84.80	22.20	26.00	10.60	7.90	41.90	*******

AGE	1998
2	157.10
3	149.60
4	201.50
5	108.50

Fishing Mortality (per year)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	.0082	.0019	.0137	.0137	.0025	.0017	.0116	.0002
2	.1227	.2958	.2491	.1676	.2721	.4023	.1885	.2435
3	.3573	.1078	.5515	.1767	.3433	.3324	.2395	.1818
4	.5320	.3449	.2485	.2193	.4111	.1059	.2680	.3395
5	.4115	.4041	.3908	.1838	.4905	.2774	.0521	.1906
6	.5090	.3033	.2506	.2179	.4976	.2655	.1613	.1697
7	.8271	.7863	.5254	.2240	.6066	.3245	.1783	.3130
8	.4846	.4035	.3940	.2125	.4668	.3114	.1934	.2582
9	.4846	.4035	.3940	.2125	.4668	.3114	.1934	.2582

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	.0172	.0177	.0230	.0333	.0087	.0231	.0498	.1244
2	.1831	.2148	.2932	.4312	.3058	.3619	.6909	.6061
3	.3603	.3079	.3641	.5788	.4678	.6213	.5615	.7376
4	.2824	.5350	.2771	.5590	.5812	.8695	.5534	.4248
5	.4686	.4073	.4464	.4665	.6316	.9551	.7583	.6874
6	.4806	.6379	.3528	.6731	.5482	.7788	.5779	.6160
7	.1761	.6516	.5723	.5992	.4755	.5785	.4727	.9725
8	.3465	.4865	.4129	.5887	.5353	.7392	.6546	.7258
9	.3465	.4865	.4129	.5887	.5353	.7392	.6546	.7258

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	.0651	.1406	.1067	.0767	.0332	.0780	.0805	.1628
2	.6469	.4660	.3042	.2370	.3009	.4023	.5541	.6742
3	.6637	.6705	.4496	.4379	.3978	.5409	.7671	1.1663
4	.7247	.6354	.5814	.6532	.5372	.5305	.5890	1.0019
5	.4345	.6356	.4858	.2201	.3646	.5222	.2908	.9062
6	.5508	.6933	.7363	.6094	.2921	.5182	.8594	.6062
7	.7465	.4423	.9688	.3053	.3073	.3939	1.1147	.7835
8	.6749	.6315	.6239	.4323	.3920	.5192	.7408	.9150
9	.6749	.6315	.6239	.4323	.3920	.5192	.7408	.9150

Table 4.4.3 ctd.

Fishing Mortality (per year)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	.0373	.0296	.0557	.0497	.0123	.0092	.0087	.0250
2	.4815	.6924	.5212	.4025	.3848	.4997	.2882	.3794
3	.7138	.6991	.7262	.4240	.6517	.6126	.4895	.4438
4	.8517	.5994	1.2066	.6677	.8168	.8573	.2437	.6282
5	.7320	.8532	1.1592	.4688	.8548	.9331	.4938	.3094
6	1.1809	.3031	1.9683	.2570	.3905	.6202	.4526	.6045
7	.5937	.6788	.5956	.7722	.1500	.7953	.3632	.7681
8	.8068	.6924	1.0921	.5348	.5795	.7713	.4163	.5559
9	.8068	.6924	1.0921	.5348	.5795	.7713	.4163	.5559

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	.0095	.0160	.0216	.0141	.0123	.0158	.0119	.0122
2	.2925	.5867	.5845	.3735	.3258	.4177	.3153	.3243
3	.4240	.5124	.8293	.4673	.4076	.5226	.3945	.4058
4	.4099	.5498	.8236	.4593	.4006	.5136	.3877	.3988
5	.5115	.5985	.6636	.4194	.3658	.4690	.3540	.3641
6	.2060	.5844	.8548	.4540	.3959	.5076	.3832	.3942
7	.5108	.1885	.7841	.4428	.3862	.4951	.3738	.3844
8	.4214	.5455	.8076	.4673	.4076	.5226	.3945	.4058
9	.4214	.5455	.8076	.4673	.4076	.5226	.3945	.4058

AGE	1998
1	.0105
2	.2777
3	.3474
4	.3415
5	.3118
6	.3375
7	.3292
8	.3474
9	.3474

Population Abundance (1 January) x 10 ^ 6

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	316.3	1026.4	330.6	246.9	489.6	275.0	1028.4	366.3
2	37.4	115.4	376.9	120.0	89.6	179.7	101.0	373.9
3	120.8	24.5	63.6	217.6	75.2	50.6	89.0	62.0
4	65.3	69.2	18.0	30.0	149.3	43.7	29.7	57.4
5	39.0	34.7	44.4	12.7	21.8	89.6	35.5	20.5
6	62.8	23.4	21.0	27.1	9.6	12.1	61.4	30.5
7	29.9	34.2	15.6	14.8	19.8	5.3	8.4	47.3
8	25.6	11.8	14.1	8.4	10.7	9.7	3.4	6.3
9	15.2	23.2	13.4	27.1	14.9	10.9	13.1	34.5

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	658.6	685.4	848.2	456.6	241.5	873.7	273.3	315.2
2	134.7	238.2	247.7	304.9	162.5	88.1	314.1	95.7
3	217.2	83.1	142.3	136.9	146.8	88.6	45.4	116.6
4	42.3	124.0	50.0	81.0	62.8	75.3	39.0	21.2
5	37.0	28.9	65.7	34.3	41.9	31.8	28.5	20.3
6	15.4	20.9	17.4	38.1	19.5	20.2	11.1	12.1
7	23.3	8.6	10.0	11.0	17.6	10.2	8.4	5.6
8	31.3	17.7	4.1	5.1	5.5	9.9	5.2	4.7
9	13.7	18.4	15.3	8.2	8.5	4.5	2.2	2.4

Table 4.4.3 ctd.

Population Abundance (1 January) x 10 ^ 6

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	137.5	152.3	206.4	173.7	135.3	237.4	145.6	409.1
2	102.4	47.4	48.7	68.3	59.2	48.1	80.8	49.4
3	38.7	39.7	22.0	26.6	39.9	32.5	23.8	34.4
4	45.7	16.3	16.6	11.5	14.1	21.9	15.5	9.1
5	12.6	20.0	7.8	8.4	5.4	7.4	11.7	7.8
6	9.2	7.4	9.6	4.3	6.1	3.4	4.0	7.9
7	5.9	4.8	3.3	4.2	2.1	4.1	1.8	1.5
8	1.9	2.5	2.8	1.1	2.8	1.4	2.5	.5
9	1.8	2.7	4.0	1.4	1.6	1.6	1.1	1.5

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	661.0	731.6	567.2	581.9	536.0	1032.7	422.4	527.4
2	127.9	234.3	261.3	197.3	203.7	194.8	376.4	154.0
3	18.7	58.5	86.8	114.9	97.8	102.7	87.5	209.0
4	8.8	7.5	23.8	34.4	61.6	41.7	45.6	43.9
5	3.0	3.4	3.7	6.4	16.0	24.6	16.0	32.3
6	2.8	1.3	1.3	1.1	3.7	6.1	8.8	8.8
7	3.9	.8	.9	.2	.7	2.2	3.0	5.0
8	.6	1.9	.4	.4	.1	.6	.9	1.9
9	1.1	.6	.3	.3	.0	.9	.3	1.7

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	450.4	190.5	767.7	357.9	915.5	964.0	470.1	423.4
2	189.2	164.1	69.0	276.4	129.8	332.7	349.1	170.9
3	78.1	104.6	67.6	28.5	140.9	69.4	162.3	188.7
4	109.8	41.8	51.3	24.2	14.6	76.8	33.7	89.6
5	21.2	65.9	21.8	20.4	13.8	8.9	41.6	20.7
6	21.5	11.5	32.8	10.2	12.1	8.7	5.0	26.4
7	4.4	15.8	5.8	12.6	5.9	7.4	4.7	3.1
8	2.1	2.4	11.8	2.4	7.3	3.6	4.1	2.9
9	1.4	1.5	1.3	1.4	1.5	2.2	3.3	1.9

AGE	1998	1999
1	887.4	615.6
2	153.9	323.0
3	91.5	86.3
4	103.0	52.9
5	54.4	66.2
6	13.0	36.0
7	16.1	8.4
8	1.9	10.5
9	1.4	2.1

Weighting factors for the catches in number

AGE	1993	1994	1995	1996	1997	1998
1	.1000	.1000	.1000	.1000	.1000	.1000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 4.4.3 ctd.

Predicted Age-Structured Index Values FLT02: celtic combined acc data (Catch: Predicted

AGE	1990	1991	1992	1993	1994	1995	1996	1997
2	294.87	190.59	80.24	397.18	195.70	457.44	531.73	*******
3	120.48	147.78	69.57	42.07	221.03	97.08	257.92	*******
4	161.09	53.37	49.78	33.73	21.63	101.51	50.57	*******
5	23.60	67.28	20.88	24.87	17.78	10.28	54.14	*******

AGE	1998
2	243.34
3	152.46
4	161.72
5	73.92

Fitted Selection Pattern

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	.0231	.0172	.0248	.0776	.0073	.0051	.0486	.0014
2	.3435	2.7430	.4518	.9482	.7927	1.2103	.7871	1.3391
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.4889	3.1979	.4507	1.2408	1.1976	.3186	1.1193	1.8668
5	1.1518	3.7472	.7087	1.0403	1.4289	.8344	.2177	1.0482
6	1.4245	2.8124	.4544	1.2330	1.4495	.7987	.6735	.9330
7	2.3148	7.2918	.9527	1.2677	1.7671	.9763	.7444	1.7214
8	1.3563	3.7420	.7145	1.2025	1.3600	.9368	.8075	1.4200
9	1.3563	3.7420	.7145	1.2025	1.3600	.9368	.8075	1.4200

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	.0476	.0574	.0631	.0575	.0185	.0372	.0886	.1687
2	.5081	.6978	.8053	.7451	.6537	.5825	1.2306	.8217
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	.7838	1.7378	.7610	.9659	1.2425	1.3995	.9856	.5759
5	1.3008	1.3231	1.2259	.8061	1.3502	1.5372	1.3506	.9319
6	1.3339	2.0721	.9689	1.1629	1.1719	1.2534	1.0292	.8352
7	.4887	2.1164	1.5718	1.0354	1.0166	.9311	.8419	1.3185
8	.9619	1.5804	1.1340	1.0172	1.1443	1.1898	1.1659	.9840
9	.9619	1.5804	1.1340	1.0172	1.1443	1.1898	1.1659	.9840

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	.0981	.2097	.2372	.1752	.0835	.1443	.1049	.1396
2	.9746	.6949	.6766	.5411	.7563	.7438	.7223	.5780
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0918	.9477	1.2930	1.4916	1.3504	.9808	.7677	.8590
5	.6547	.9479	1.0804	.5027	.9165	.9655	.3791	.7770
6	.8298	1.0339	1.6375	1.3917	.7342	.9581	1.1203	.5198
7	1.1246	.6596	2.1545	.6971	.7725	.7282	1.4530	.6718
8	1.0168	.9417	1.3876	.9872	.9854	.9599	.9657	.7845
9	1.0168	.9417	1.3876	.9872	.9854	.9599	.9657	.7845

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	.0522	.0424	.0767	.1173	.0189	.0150	.0177	.0564
2	.6745	.9905	.7178	.9491	.5904	.8156	.5888	.8549
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.1930	.8575	1.6616	1.5746	1.2534	1.3994	.4978	1.4156
5	1.0254	1.2205	1.5963	1.1056	1.3117	1.5230	1.0087	.6973
6	1.6544	.4335	2.7105	.6060	.5992	1.0124	.9246	1.3623
7	.8317	.9710	.8202	1.8211	.2302	1.2981	.7419	1.7309
8	1.1302	.9905	1.5039	1.2612	.8892	1.2589	.8503	1.2527
9	1.1302	.9905	1.5039	1.2612	.8892	1.2589	.8503	1.2527

Table 4.4.3 ctd.

Fitted Selection Pattern

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	.0225	.0312	.0261	.0302	.0302	.0302	.0302	.0302
2	.6897	1.1451	.7049	.7993	.7993	.7993	.7993	.7993
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	.9666	1.0731	.9932	.9828	.9828	.9828	.9828	.9828
5	1.2063	1.1682	.8002	.8975	.8975	.8975	.8975	.8975
6	.4858	1.1406	1.0308	.9714	.9714	.9714	.9714	.9714
7	1.2045	.3680	.9455	.9475	.9475	.9475	.9475	.9475
8	.9937	1.0648	.9738	1.0000	1.0000	1.0000	1.0000	1.0000
9	.9937	1.0648	.9738	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1998
1	.0302
2	.7993
3	1.0000
4	.9828
5	.8975
6	.9714
7	.9475
8	1.0000
9	1.0000

Table 4.4.3 ctd. STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 7	SoP (%)
1958	316280	127509	88497	22978	.2596	.4599	73
1959	1026360	191757	98882	15086	.1526	.3737	70
1960	330630	148664	104053	18283	.1757	.3693	67
1961	246920	125386	93589	15372	.1642	.1982	100
1962	489630	141649	90042	21552	.2394	.4369	82
1963	274960	115347	81332	17349	.2133	.2847	85
1964	1028370	192435	101389	10599	.1045	.1813	85
1965	366290	169405	121789	19126	.1570	.2397	75
1966	658570	185594	116961	27030	.2311	.3252	96
1967	685420	190385	117949	27658	.2345	.4591	85
1968	848170	210361	124613	30236	.2426	.3843	96
1969	456550	177520	117537	44389	.3777	.5513	94
1970	241470	124888	88946	31727	.3567	.5017	96
1971	873690	171112	86986	31396	.3609	.6942	94
1972	273320	118529	77371	38203	.4938	.6025	98
1973	315160	93762	56284	26936	.4786	.6741	95
1974	137500	60184	40033	19940	.4981	.6278	99
1975	152250	47270	29286	15588	.5322	.5905	113
1976	206440	47698	26830	9771	.3642	.5877	99
1977	173710	45025	26931	7833	.2908	.4105	104
1978	135270	42082	26897	7559	.2810	.3666	98
1979	237350	52117	28604	10321	.3608	.4847	103
1980	145560	44682	27255	13130	.4817	.6959	108
1981	409070	69838	31059	17103	.5506	.8564	103
1982	661030	107158	47360	13000	.2745	.7589	95
1983	731640	141020	68778	24981	.3632	.6377	93
1984	567150	112485	62070	26779	.4314	1.0295	99
1985	581930	116616	63859	20426	.3199	.4987	102
1986	536000	124505	69742	25024	.3588	.5414	100
1987	1032700	160550	78607	26200	.3333	.7197	99
1988	422380	120867	78642	20447	.2600	.3885	100
1989	527370	124667	73734	23254	.3154	.5222	100
1990	450420	111002	69559	18404	.2646	.3924	99
1991	190450	83172	58910	25562	.4339	.5034	101
1992	767720	116197	55876	21127	.3781	.7567	95
1993	357920	87049	54304	18618	.3428	.4360	100
1994	915520	140997	70412	19300	.2741	.3803	99
1995	964000	157116	84461	23305	.2759	.4876	100
1996	470080	123080	80467	18816	.2338	.3681	100
1997	423390	111546	72637	20496	.2822	.3786	99
1998	887350	152974	82500	18214	.2208	.3242	99

```
IFAP run code: I07
 ---------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1958  . . . 1998
Number of indices of SSB : 0
Number of age-structured indices : 1
Parameters to estimate : 29
Number of observations : 80
Conventional single selection vector model to be fitted.
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```

Table 4.4.3 ctd.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	UUpper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1993	.4673	15	.3467	.6298	.4013	.5442	.4728
2	1994	.4076	15	.3035	.5474	.3506	.4738	.4122
3	1995	.5226	14	.3898	.7005	.4500	.6068	.5284
4	1996	.3945	16	.2858	.5446	.3347	.4650	.3999
5	1997	.4057	18	.2814	.5850	.3367	.4890	.4129
6	1998	.3474	21	.2277	.5301	.2801	.4310	.3556
Separable Model: Selection (S) by age								
7	1	.0302	42	.0132	.0690	.0198	.0460	.0330
8	2	.7993	16	.5785	1.1044	.6778	.9426	.8102
	3	1.0000		Fixed : Reference Age				
9	4	.9828	15	.7283	1.3262	.8435	1.1451	.9943
10	5	.8975	14	.6738	1.1954	.7754	1.0388	.9071
11	6	.9714	14	.7369	1.2806	.8437	1.1185	.9811
12	7	.9475	14	.7148	1.2560	.8206	1.0940	.9573
	8	1.0000		Fixed : Last true age				
Separable model: Populations in year 1998								
13	1	887349	100	123603	6370276	324584	2425838	1471369
14	2	153862	24	94377	250838	119904	197437	158720
15	3	91530	21	60084	139433	73840	113456	93665
16	4	102949	19	70653	150008	84959	124749	104866
17	5	54392	18	37760	78350	45151	65525	55343
18	6	13012	19	8814	19211	10667	15874	13272
19	7	16100	20	10712	24197	13078	19819	16451
20	8	1903	23	1208	2998	1510	2400	1955
Separable model: Populations at age								
21	1993	2396	30	1309	4385	1760	3262	2513
22	1994	7334	24	4525	11887	5733	9383	7560
23	1995	3596	21	2338	5531	2887	4479	3684
24	1996	4070	21	2685	6169	3292	5032	4163
25	1997	2938	21	1944	4441	2380	3627	3004

Age-structured index catchabilities

FLT02: celtic combined acc data (Catch:

Linear model fitted. Slopes at age :

26	2	Q	.2818E-02	14	.2459E-02	.4290E-02	.2818E-02	.3744E-02	.3281E-02
27	3	Q	.2880E-02	14	.2510E-02	.4398E-02	.2880E-02	.3833E-02	.3357E-02
28	4	Q	.2443E-02	14	.2126E-02	.3747E-02	.2443E-02	.3261E-02	.2852E-02
29	5	Q	.2052E-02	14	.1782E-02	.3166E-02	.2052E-02	.2751E-02	.2401E-02

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1993	1994	1995	1996	1997	1998
1	-.6796	.5379	-.0104	-.0128	.1657	.0000
2	.2249	.1290	-.2252	-.2833	-.0963	.2569
3	-.0353	.3606	-.1343	-.2328	-.0793	.1094
4	.1845	-.3363	.2153	-.2641	.1115	.0055
5	-.3950	-.2889	.1517	.3094	.3216	-.0433
6	-.2404	.2322	.0365	.3099	-.2900	.0630
7	.3186	-.0435	-.0384	.1208	.1976	-.4687
8	.0000	-.3186	.2839	.1734	-.1239	.1207

Table 4.4.3 ctd.

AGE-STRUCTURED INDEX RESIDUALS FLT02: celtic combined acc data (Catch:

Age	1990	1991	1992	1993	1994	1995	1996	1997
2	-.1691	.0239	.3771	.0976	-.4308	.1855	.3532	*******
3	-.1038	-.4450	.2327	.3332	-.3213	.3546	-.0316	*******
4	-.0548	.0118	-.0036	.6309	-.7228	-.0822	.0007	*******
5	.3167	.2314	.0611	.0445	-.5173	-.2638	-.2563	*******

Age	1998
2	-.4376
3	-.0189
4	.2199
5	.3837

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1993 to 1998

Variance	.0969
Skewness test stat.	-.5679
Kurtosis test statistic	-1.3282
Partial chi-square	.2546
Significance in fit	.0000
Degrees of freedom	23

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT02: celtic combined acc data (Catch:

Linear catchability relationship assumed

Age	2	3	4	5
Variance	.0640	.0540	.0874	.0634
Skewness test stat.	-.3417	-.1963	-.3929	-.3969
Kurtosis test statisti	-.7533	-.7069	.3593	-.6737
Partial chi-square	.0842	.0820	.1842	.1374
Significance in fit	.0000	.0000	.0000	.0000
Number of observations	8	8	8	8
Degrees of freedom	7	7	7	7
Weight in the analysis	.6250	.6250	.6250	.6250

ANALYSIS OF VARIANCE

Unweighted Statistics
Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	5.9409	80	29	51	.1165
Catches at age	2.9309	48	25	23	.1274
Aged Indices					
FLT02: celtic combined acc data (Catch	3.0100	32	4	28	.1075

Weighted Statistics
Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	3.4056	80	29	51	.0668
Catches at age	2.2298	48	25	23	.0969
Aged Indices					
FLT02: celtic combined acc data (Catch	1.1758	32	4	28	.0420

Table 4.6.1

The SAS System 18:18 Monday, March 22, 1999
Herring South and SW of Ireland (Celtic Sea + VIIj)
Single option prediction: Input data

Year: 1999

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	565.500	1.0000	0.5000	0.2000	0.5000	0.093	0.0105	0.093
2	323.000	0.3000	1.0000	0.2000	0.5000	0.126	0.2777	0.126
3	86.300	0.2000	1.0000	0.2000	0.5000	0.153	0.3474	0.153
4	52.900	0.1000	1.0000	0.2000	0.5000	0.169	0.3415	0.169
5	66.200	0.1000	1.0000	0.2000	0.5000	0.185	0.3118	0.185
6	36.000	0.1000	1.0000	0.2000	0.5000	0.198	0.3375	0.198
7	8.400	0.1000	1.0000	0.2000	0.5000	0.208	0.3292	0.208
8	10.500	0.1000	1.0000	0.2000	0.5000	0.218	0.3474	0.218
9+	2.100	0.1000	1.0000	0.2000	0.5000	0.228	0.3474	0.228
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2000

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	565.500	1.0000	0.5000	0.2000	0.5000	0.093	0.0105	0.093
2	.	0.3000	1.0000	0.2000	0.5000	0.126	0.2777	0.126
3	.	0.2000	1.0000	0.2000	0.5000	0.153	0.3474	0.153
4	.	0.1000	1.0000	0.2000	0.5000	0.169	0.3415	0.169
5	.	0.1000	1.0000	0.2000	0.5000	0.185	0.3118	0.185
6	.	0.1000	1.0000	0.2000	0.5000	0.198	0.3375	0.198
7	.	0.1000	1.0000	0.2000	0.5000	0.208	0.3292	0.208
8	.	0.1000	1.0000	0.2000	0.5000	0.218	0.3474	0.218
9+	.	0.1000	1.0000	0.2000	0.5000	0.228	0.3474	0.228
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2001

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	565.500	1.0000	0.5000	0.2000	0.5000	0.093	0.0105	0.093
2	.	0.3000	1.0000	0.2000	0.5000	0.126	0.2777	0.126
3	.	0.2000	1.0000	0.2000	0.5000	0.153	0.3474	0.153
4	.	0.1000	1.0000	0.2000	0.5000	0.169	0.3415	0.169
5	.	0.1000	1.0000	0.2000	0.5000	0.185	0.3118	0.185
6	.	0.1000	1.0000	0.2000	0.5000	0.198	0.3375	0.198
7	.	0.1000	1.0000	0.2000	0.5000	0.208	0.3292	0.208
8	.	0.1000	1.0000	0.2000	0.5000	0.218	0.3474	0.218
9+	.	0.1000	1.0000	0.2000	0.5000	0.228	0.3474	0.228
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRJM02
Date and time: 22MAR99:19:05

Table 4.6.2

The SAS System 18:18 Monday, March 22, 1999
Herring South and SW of Ireland (Celtic Sea + VIIj)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.0000	0.3242	142100	21254	1150900	139324	868150	113028	663806	89436
2000	1.0000	0.3242	140128	21692	1117187	137540	834437	111244	638205	88279
2001	1.0000	0.3242	135620	21230	1098473	135486	815723	109191	624469	86895
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRJM02
Date and time : 22MAR99:19:05
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : F factors

Table 4.6.3

The SAS System 18:18 Monday, March 22, 1999
Herring South and SW of Ireland (Celtic Sea + VIIj)

Single option prediction: Detailed tables

Year: 1999 F-factor: 1.0000 Reference F: 0.3242

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January: Sp.stock size	1 January: Sp.stock biomass	Spawning time: Sp.stock size	Spawning time: Sp.stock biomass
1	0.0105	3737	348	565500	52592	282750	26296	171137	15916
2	0.2777	68133	8585	323000	40698	323000	40698	262989	33137
3	0.3474	23088	3532	86300	13204	86300	13204	72846	11145
4	0.3415	14605	2468	52900	8940	52900	8940	46998	7943
5	0.3118	16919	3130	66200	12247	66200	12247	59164	10945
6	0.3375	9841	1948	36000	7128	36000	7128	32009	6338
7	0.3292	2248	468	8400	1747	8400	1747	7481	1556
8	0.3474	2941	641	10500	2289	10500	2289	9318	2031
9+	0.3474	588	134	2100	479	2100	479	1864	425
Total		142100	21254	1150900	139324	868150	113028	663806	89436
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2000 F-factor: 1.0000 Reference F: 0.3242

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January: Sp.stock size	1 January: Sp.stock biomass	Spawning time: Sp.stock size	Spawning time: Sp.stock biomass
1	0.0105	3737	348	565500	52592	282750	26296	171137	15916
2	0.2777	43424	5471	205863	25939	205863	25939	167615	21120
3	0.3474	48493	7419	181264	27733	181264	27733	153005	23410
4	0.3415	13782	2329	49920	8437	49920	8437	44351	7495
5	0.3118	8694	1608	34018	6293	34018	6293	30403	5625
6	0.3375	11988	2374	43855	8683	43855	8683	38993	7721
7	0.3292	6221	1294	23243	4835	23243	4835	20701	4306
8	0.3474	1532	334	5469	1192	5469	1192	4853	1058
9+	0.3474	2256	514	8055	1837	8055	1837	7148	1630
Total		140128	21692	1117187	137540	834437	111244	638205	88279
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2001 F-factor: 1.0000 Reference F: 0.3242

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January: Sp.stock size	1 January: Sp.stock biomass	Spawning time: Sp.stock size	Spawning time: Sp.stock biomass
1	0.0105	3737	348	565500	52592	282750	26296	171137	15916
2	0.2777	43424	5471	205863	25939	205863	25939	167615	21120
3	0.3474	30907	4729	115528	17676	115528	17676	97517	14920
4	0.3415	28948	4892	104852	17720	104852	17720	93154	15743
5	0.3118	8205	1518	32102	5939	32102	5939	28691	5308
6	0.3375	6160	1220	22536	4462	22536	4462	20037	3967
7	0.3292	7579	1576	28315	5889	28315	5889	25218	5245
8	0.3474	4238	924	15132	3299	15132	3299	13428	2927
9+	0.3474	2422	552	8646	1971	8646	1971	7672	1749
Total		135620	21230	1098473	135486	815723	109191	624469	86895
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRJM02
Date and time : 22MAR99:19:05
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : F factors

Table 4.6.4

The SAS System 18:18

Monday, March 22, 1999

Herring South and SW of Ireland (Celtic Sea + VIIj)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
0.9862	0.3198	138719	89315	21000	0.6000	0.1945	136890	89971	13813	142444	95410
.	.	.	.	.	0.6500	0.2108	.	89731	14853	141400	94215
.	.	.	.	.	0.7000	0.2270	.	89492	15876	140373	93042
.	.	.	.	.	0.7500	0.2432	.	89253	16884	139362	91890
.	.	.	.	.	0.8000	0.2594	.	89015	17877	138368	90760
.	.	.	.	.	0.8500	0.2756	.	88778	18854	137389	89651
.	.	.	.	.	0.9000	0.2918	.	88542	19817	136425	88561
.	.	.	.	.	0.9500	0.3080	.	88306	20765	135477	87492
.	.	.	.	.	1.0000	0.3242	.	88071	21698	134544	86442
.	.	.	.	.	1.0500	0.3404	.	87837	22618	133626	85412
.	.	.	.	.	1.1000	0.3567	.	87604	23523	132722	84400
.	.	.	.	.	1.1500	0.3729	.	87371	24414	131832	83407
.	.	.	.	.	1.2000	0.3891	.	87139	25292	130956	82432
.	.	.	.	.	1.2500	0.4053	.	86908	26157	130095	81474
.	.	.	.	.	1.3000	0.4215	.	86678	27008	129246	80535
.	.	.	.	.	1.3500	0.4377	.	86448	27847	128412	79612
.	.	.	.	.	1.4000	0.4539	.	86220	28673	127590	78706
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANJM04
Date and time : 22MAR99:18:19
Computation of ref. F: Simple mean, age 2 - 7
Basis for 1999 : TAC constraints

Table 4.7.1

Celtic Sea herring
Medium term simulation with stochastic recruitment at a low level from year 1 onwards.
Fishing mortality assumed constant at 0.27

Year	%<25000t	%25-40000t	%>40000t
1	0.0	0.0	100.0
2	0.0	0.0	100.0
3	0.0	0.0	100.0
4	0.0	0.0	100.0
5	0.0	0.0	100.0
6	0.0	5.3	94.7
7	0.0	38.3	61.7
8	0.0	69.1	30.9
9	0.0	83.9	16.1
10	0.0	90.1	9.9

Fractiles for SSB:

Year	5%	25%	50%	75%	95%
1	90915.8	91916.6	92776.1	93951.4	96426.7
2	72388.5	74300.1	75943.5	78047.5	81482.1
3	60287.0	62459.4	64399.4	66592.4	70335.3
4	51813.9	54158.9	56220.3	58635.6	62130.5
5	44930.6	47856.4	49733.0	52190.6	55553.5
6	39912.7	42577.4	44746.0	47147.0	50826.3
7	36294.3	38915.7	40956.6	43191.4	47178.0
8	33458.4	36234.8	38314.6	40608.2	44491.1
9	31772.1	34482.3	36470.6	38819.6	42609.6
10	30429.4	33047.6	35233.2	37330.3	41336.8

Fractiles for Recruitment:

Year	5%	25%	50%	75%	95%
1	123661.2	160265.5	190992.1	235580.8	311973.8
2	127842.3	166720.3	195377.6	229776.8	294917.3
3	121078.2	162925.8	196574.2	231842.6	300736.2
4	124901.9	163362.3	195972.6	233951.6	303632.3
5	125087.5	162079.6	195788.0	235796.5	310656.0
6	128758.7	164510.3	193550.3	232633.1	297612.0
7	126645.2	163366.6	195399.4	234759.4	305644.8
8	125828.6	162724.0	196839.7	237271.1	307825.0
9	126778.0	163690.9	196316.6	229196.3	298960.7
10	122787.3	161894.5	196478.9	232370.3	301636.9

Fractiles for Catches:

Year	5%	25%	50%	75%	95%
1	21663.7	21681.4	21696.6	21717.3	21761.0
2	17595.2	17875.3	18119.3	18442.9	19111.2
3	13953.4	14408.3	14784.7	15246.3	16010.3
4	11878.7	12344.3	12781.8	13252.3	14056.4
5	10362.4	10885.6	11295.7	11790.2	12508.5
6	8936.8	9547.5	9950.1	10468.6	11188.5
7	7913.2	8499.2	8940.8	9426.2	10244.9
8	7229.0	7787.5	8203.5	8708.4	9484.9
9	6729.4	7295.8	7735.5	8225.6	9041.4
10	6404.9	6981.1	7426.7	7917.1	8718.3

Table 4.7.2

Celtic Sea herring
Medium term simulation with stochastic recruitment at a low level from year 1 onwards.
Fishing mortality assumed constant at 0.40

Year	%<25000t	%25-40000t	%>40000t
1	0.0	0.0	100.0
2	0.0	0.0	100.0
3	0.0	0.0	100.0
4	0.0	16.4	83.6
5	0.0	86.2	13.8
6	0.6	98.1	1.3
7	7.8	92.1	0.1
8	23.6	76.4	0.0
9	36.1	63.9	0.0
10	44.6	55.4	0.0

Fractiles for SSB:

Year	5%	25%	50%	75%	95%
1	88705.7	89705.7	90564.6	91738.9	94212.2
2	63176.0	65055.4	66680.3	68741.0	72097.8
3	47966.3	50036.4	51843.0	53979.4	57485.3
4	38639.6	40741.5	42667.2	44834.4	48086.4
5	32033.2	34621.4	36408.9	38628.6	41840.4
6	28004.4	30337.8	32266.6	34493.5	37721.1
7	25325.3	27810.4	29570.8	31707.3	35193.2
8	23727.9	26125.7	28033.7	30139.2	33718.4
9	22891.7	25254.3	27101.9	29330.4	32687.5
10	21956.6	24517.6	26451.5	28482.2	31984.5

Fractiles for Recruitment:

Year	5%	25%	50%	75%	95%
1	123661.2	160265.5	190992.1	235580.8	311973.8
2	127842.3	166720.3	195377.6	229776.8	294917.3
3	121078.2	162925.8	196574.2	231842.6	300736.2
4	124901.9	163362.3	195972.6	233951.6	303632.3
5	125087.5	162079.6	195788.0	235796.5	310656.0
6	128758.7	164510.3	193550.3	232633.1	297612.0
7	126645.2	163366.6	195367.7	234759.4	305644.8
8	124915.0	162158.6	196741.1	236918.7	307825.0
9	124364.1	161263.4	194141.2	226375.8	294653.4
10	120388.7	158339.7	189374.8	226937.8	296986.7

Fractiles for Catches:

Year	5%	25%	50%	75%	95%
1	30254.1	30280.2	30302.6	30333.3	30397.9
2	21743.3	22139.1	22479.2	22935.8	23875.9
3	15508.4	16101.6	16619.7	17221.7	18226.3
4	12130.4	12778.8	13315.7	13920.9	14939.2
5	9964.1	10654.3	11160.1	11769.9	12706.2
6	8320.0	9073.6	9570.3	10201.2	11148.1
7	7357.5	8039.4	8590.0	9184.5	10217.7
8	6783.9	7429.5	7958.1	8533.6	9541.8
9	6393.1	7062.5	7594.1	8210.5	9220.8
10	6146.3	6858.2	7391.1	7996.9	9001.5

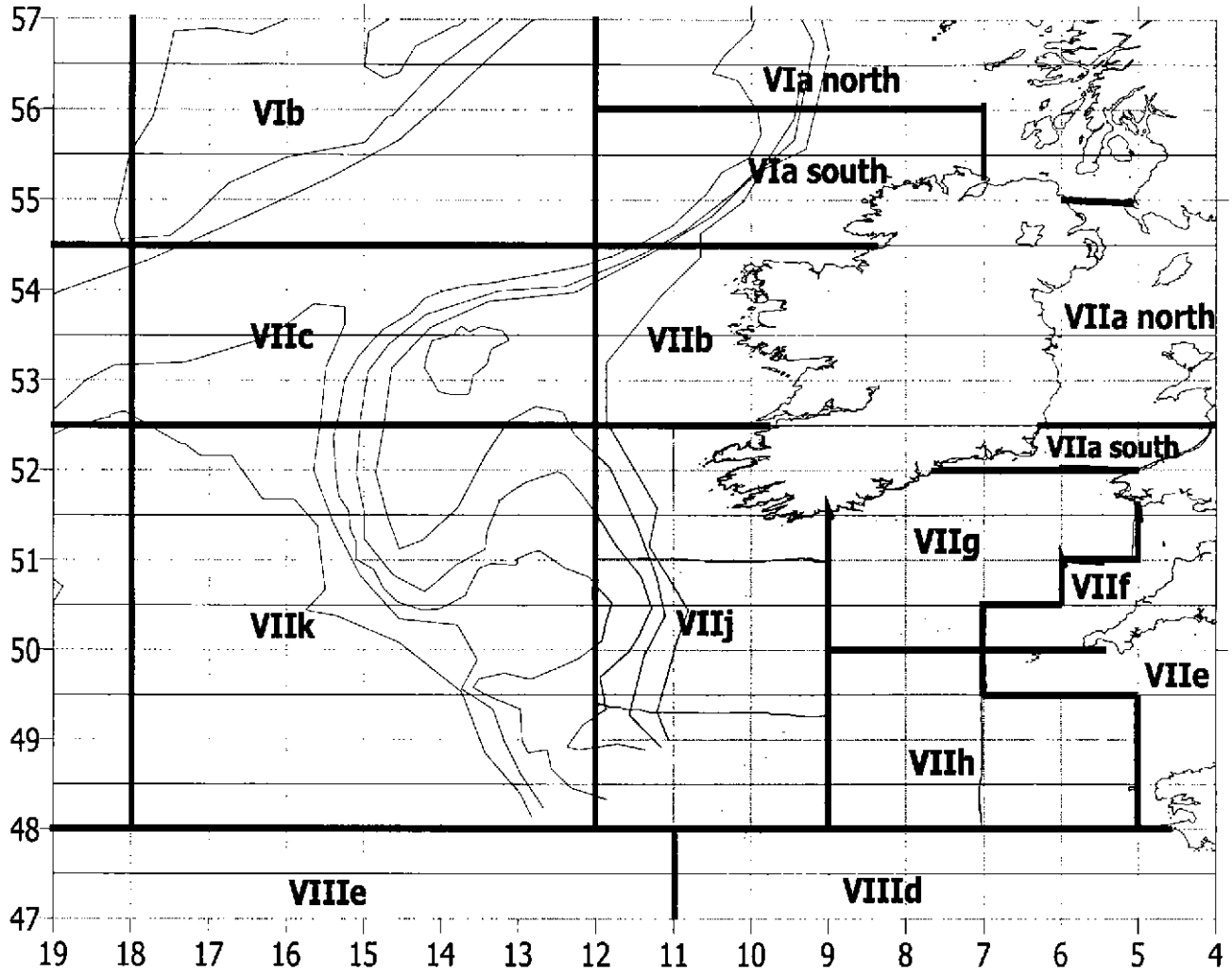


Figure 4.1.1 The assessment covers the Divisions VIIg and VIIj and that part of VIIa below 52° 30. The TAC is set by the EU for Divisions VIIg-k and that section of VIIa below 52° 30.

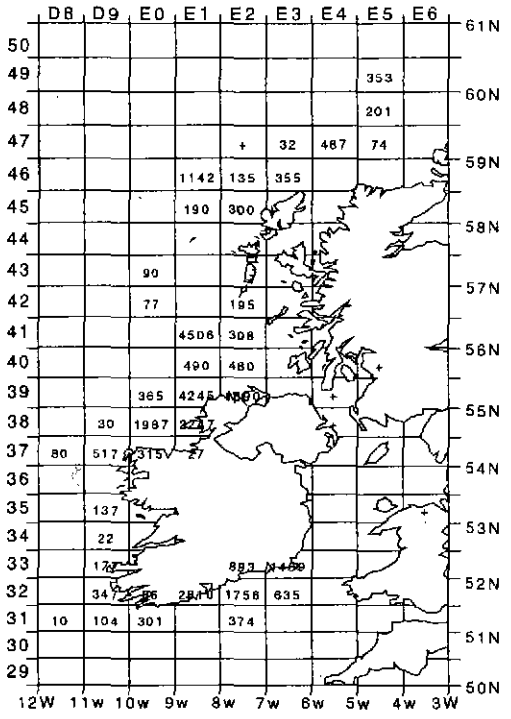


Figure 4.2.1a : Distribution of herring catches Quarter 1 – 1998.

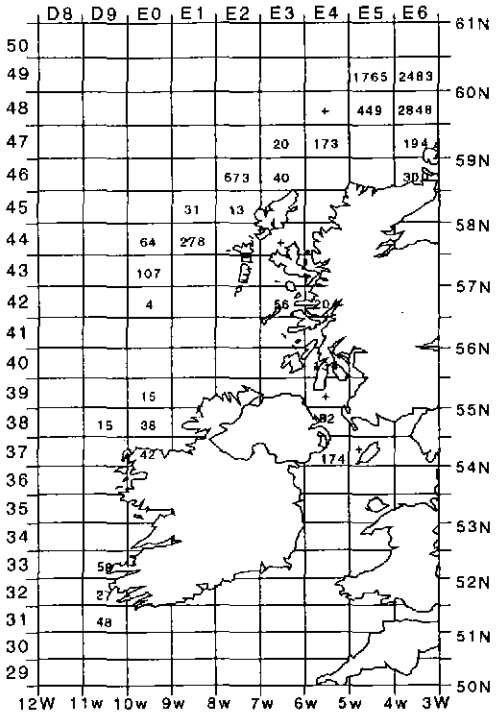


Figure 4.2.1b : Distribution of herring catches Quarter 2 – 1998.

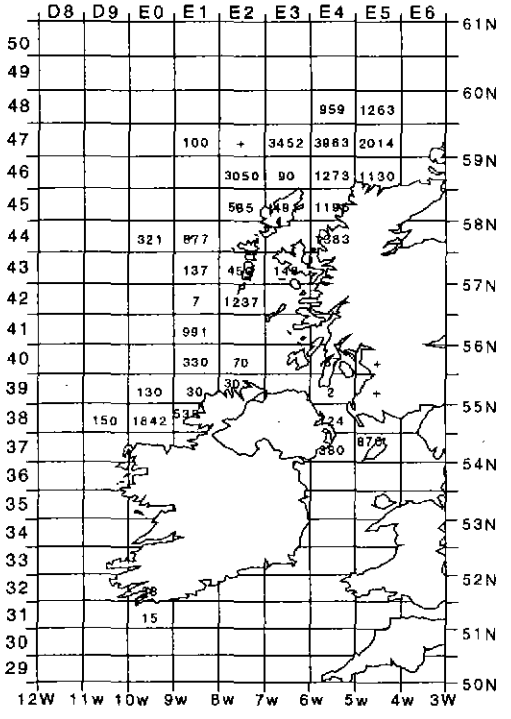


Figure 4.2.1c : Distribution of herring catches Quarter 3 – 1998.

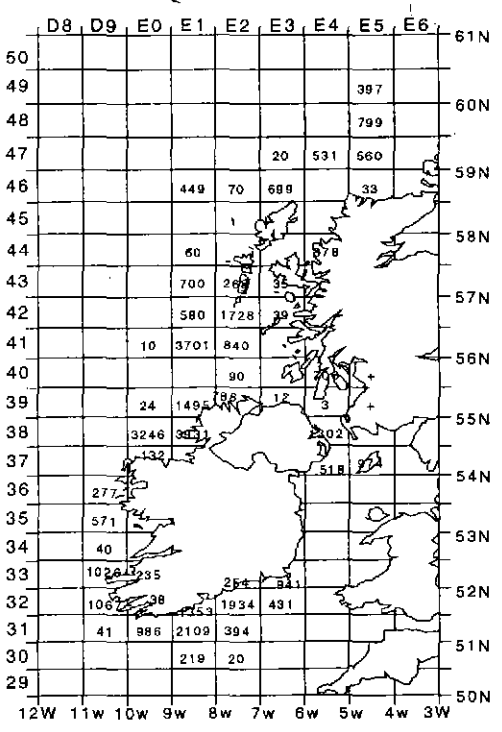


Figure 4.2.1d : Distribution of herring catches Quarter 4 – 1998.

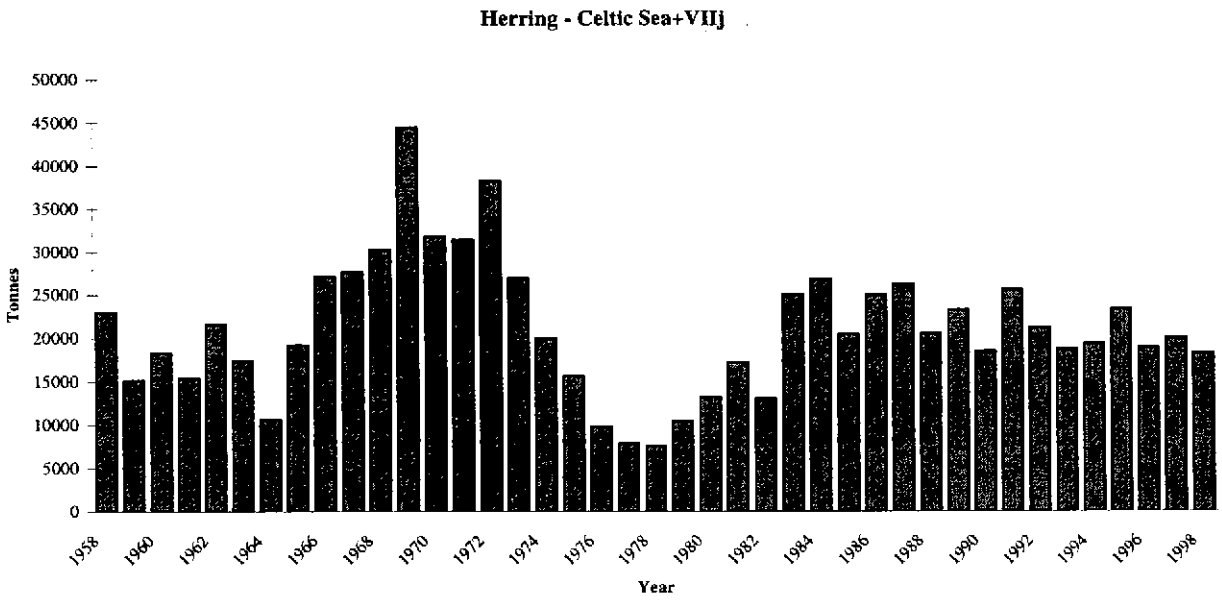


Figure 4.2.2. Herring catches in Celtic Sea and Division VIIj: 1958-1998

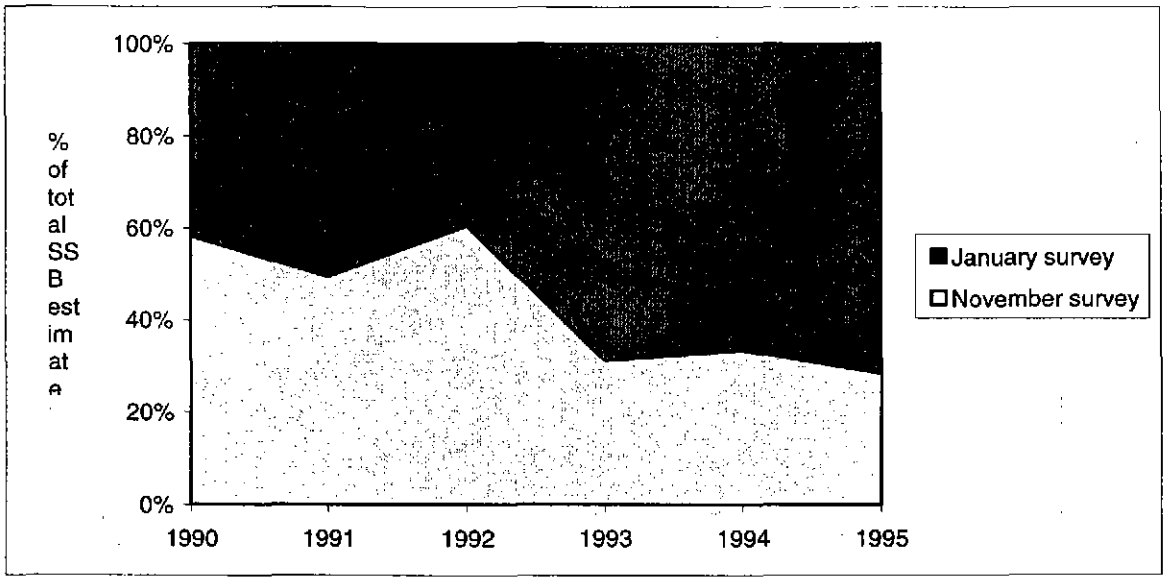


Figure 4.4.1 Relative proportion of SSB estimate from January and November acoustic surveys over the period 1990 to 1995

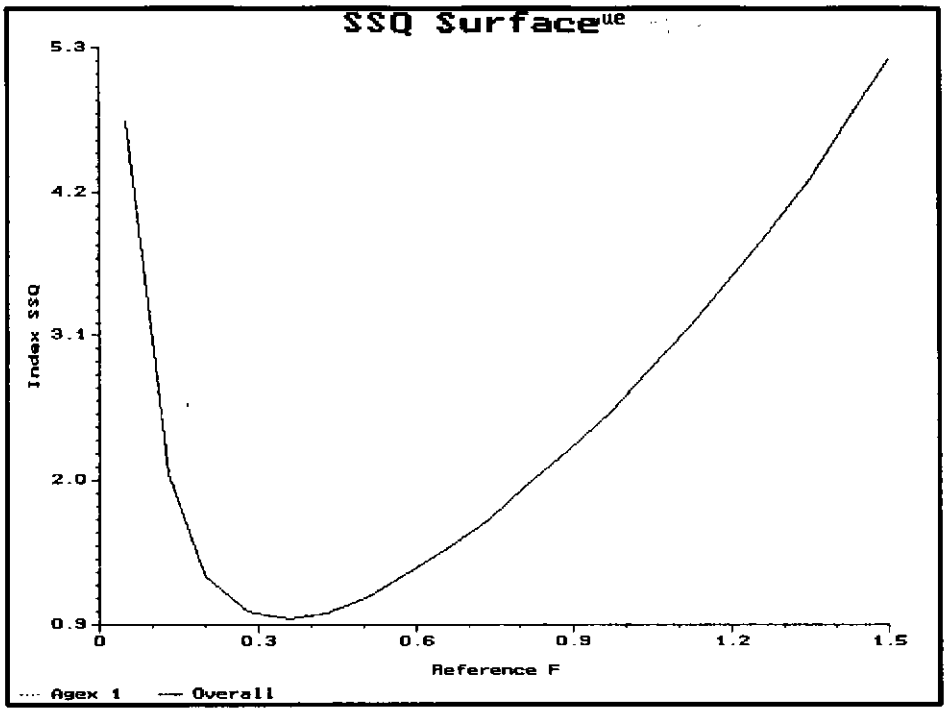


Figure 4.4.2a Herring in Celtic Sea and Division VIIj. SSQ surface for the baseline assessment.

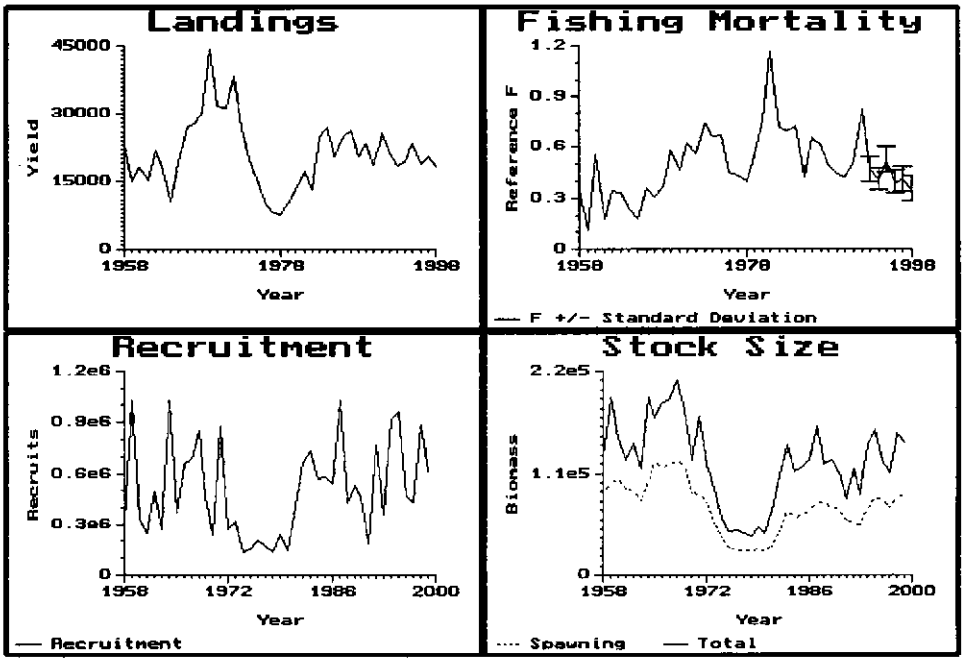


Figure 4.4.2b Herring in Celtic Sea and Division VIIj. Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 3, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

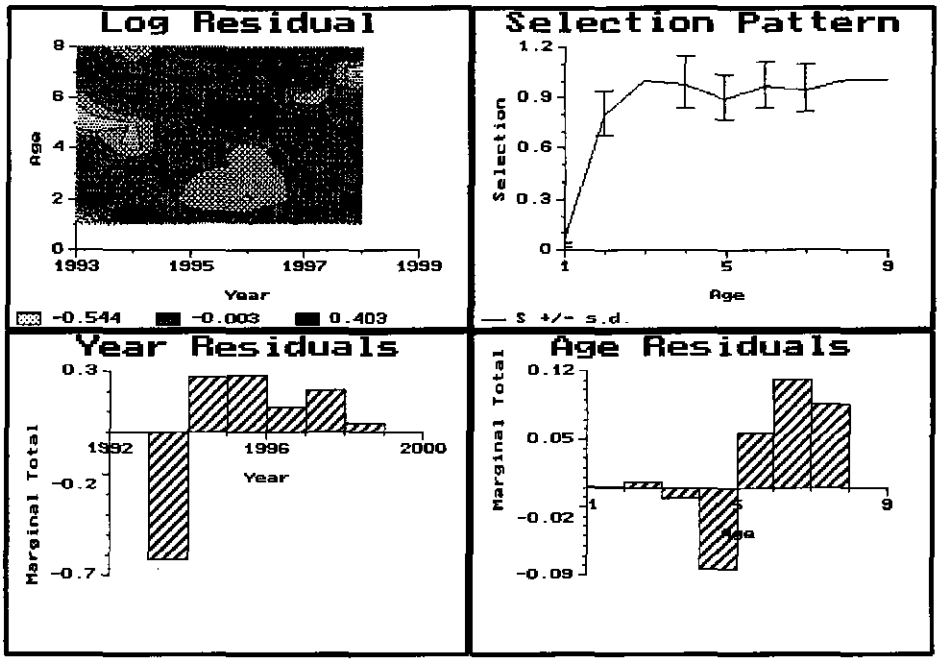


Figure 4.4.3. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 3) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

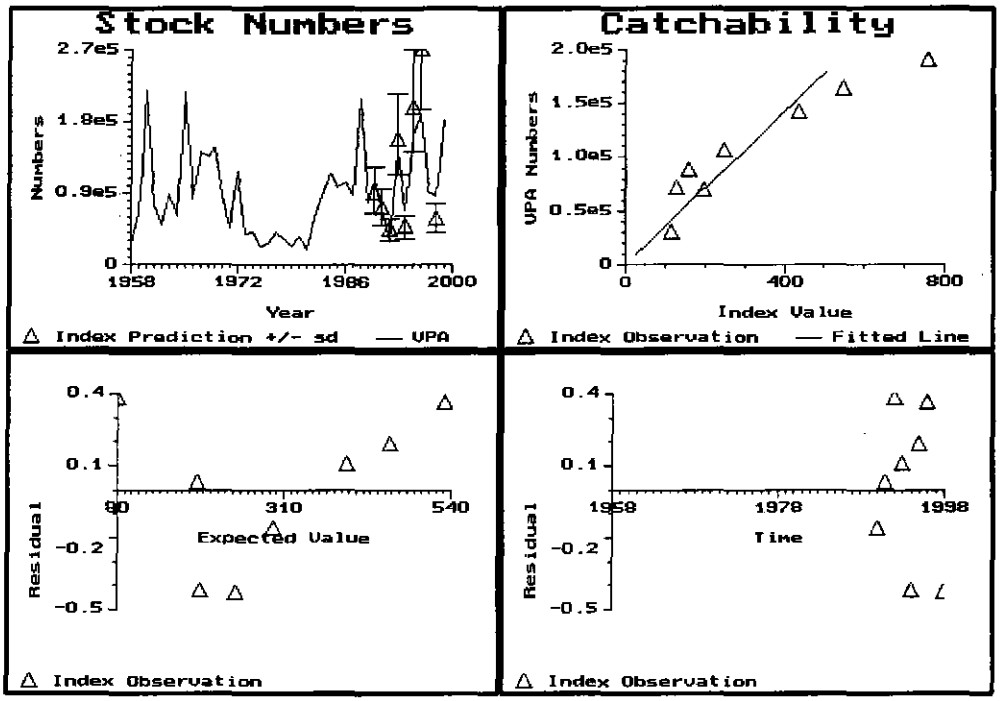


Figure 4.4.4. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 2 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

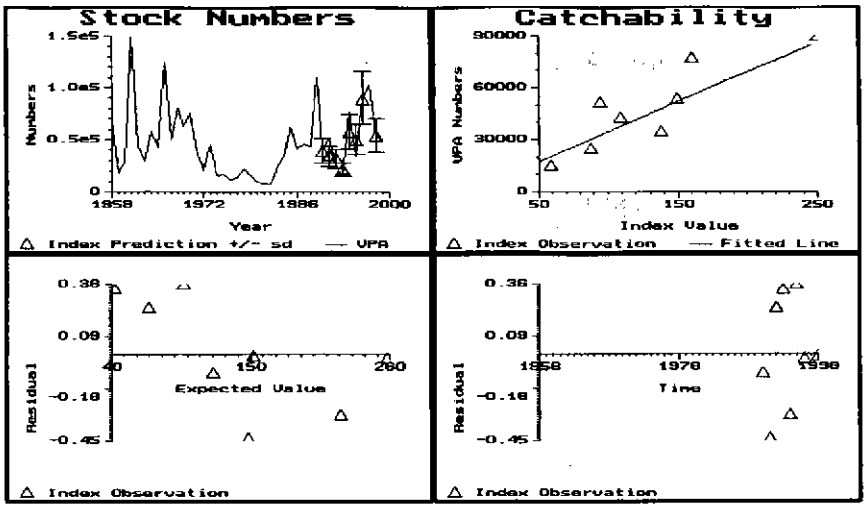


Figure 4.4.5. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic index at age 3 against the estimated populations at age 1-ring. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and 1-ringer survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

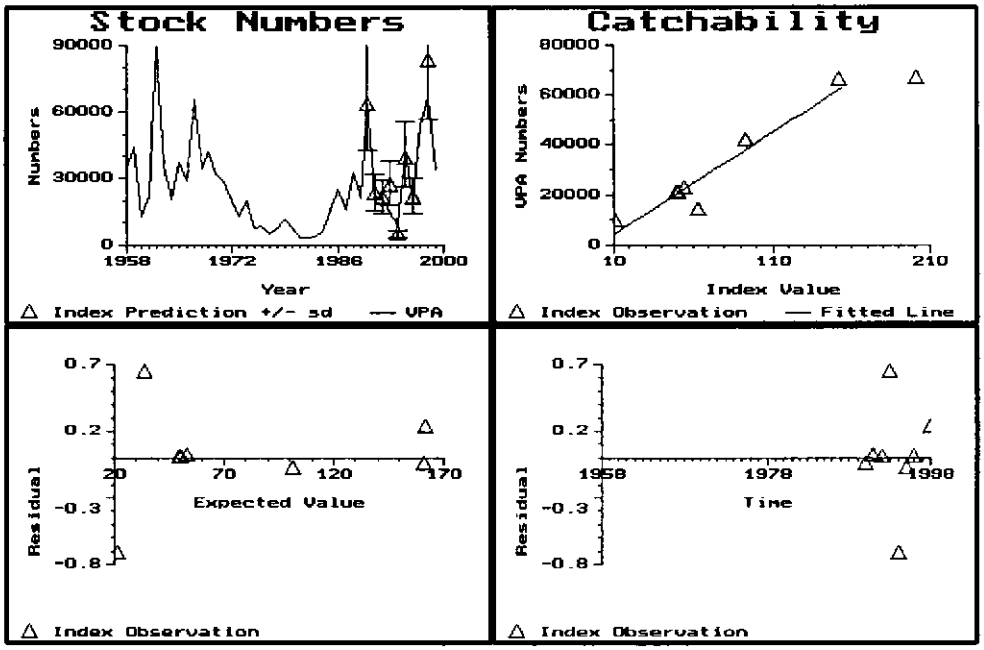


Figure 4.4.6. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 4 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

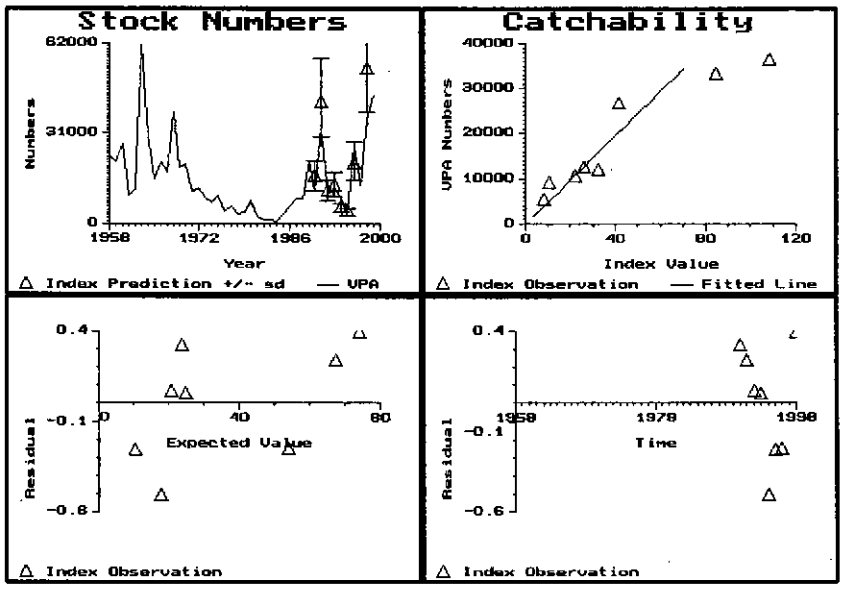


Figure 4.4.7. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 5 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

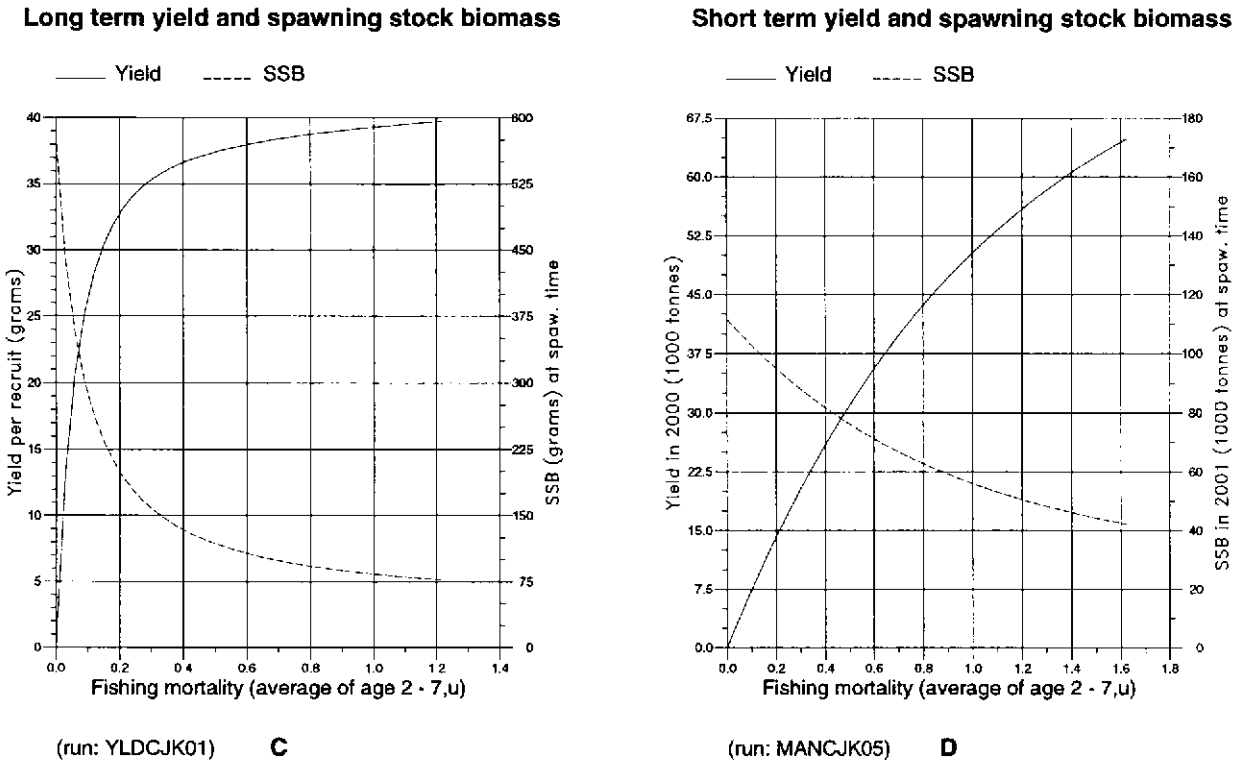


Figure 4.6.1. Long and short term yield and SSB

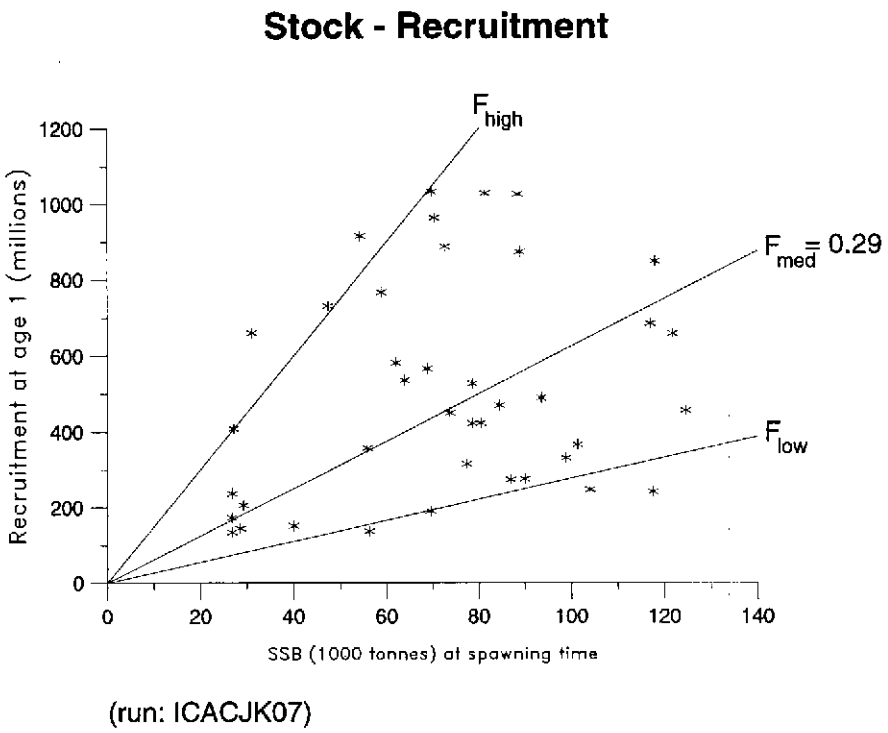
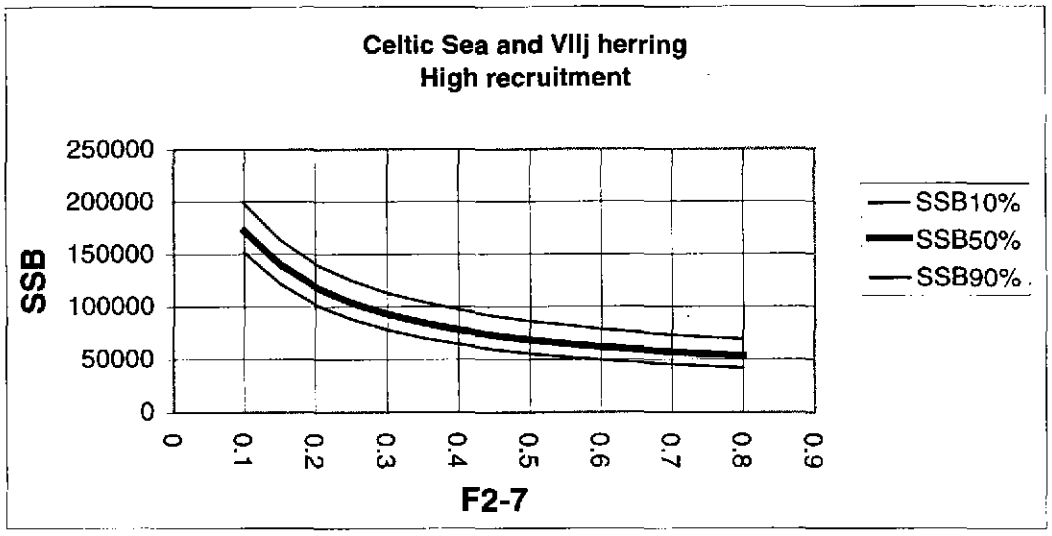
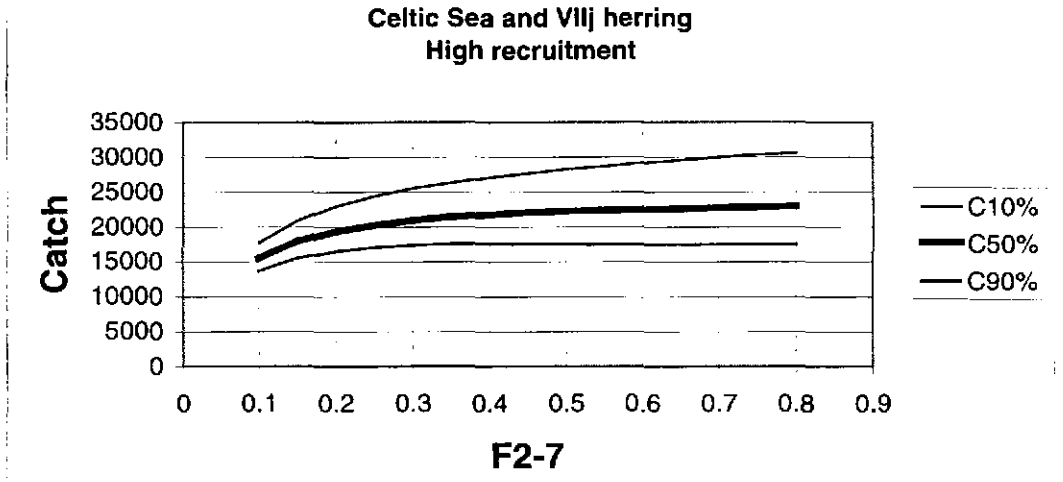


Figure 4.6.2 Stock and recruitment for Celtic Sea and VIIj Herring





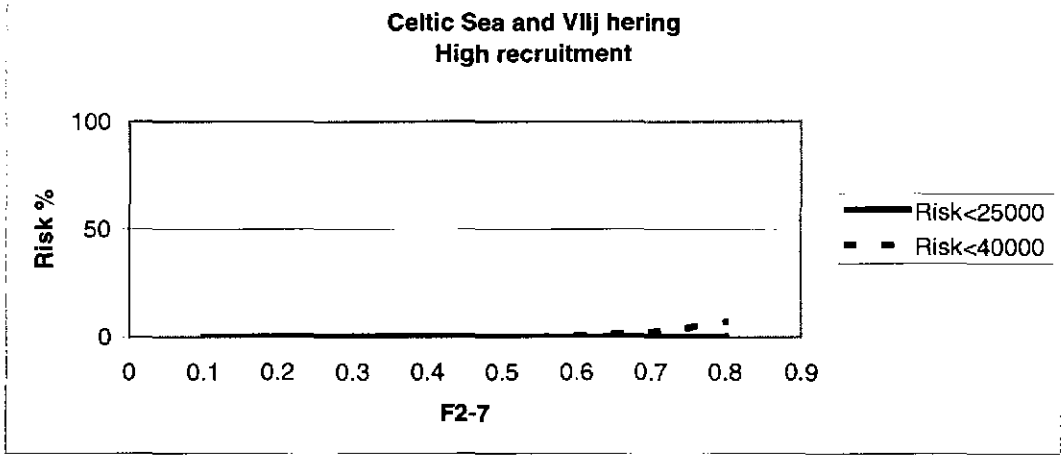
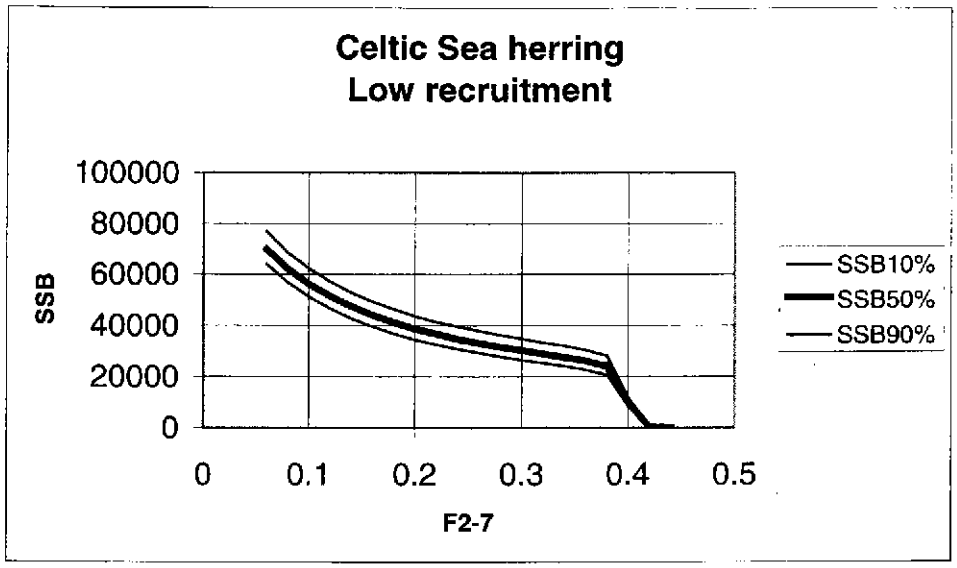
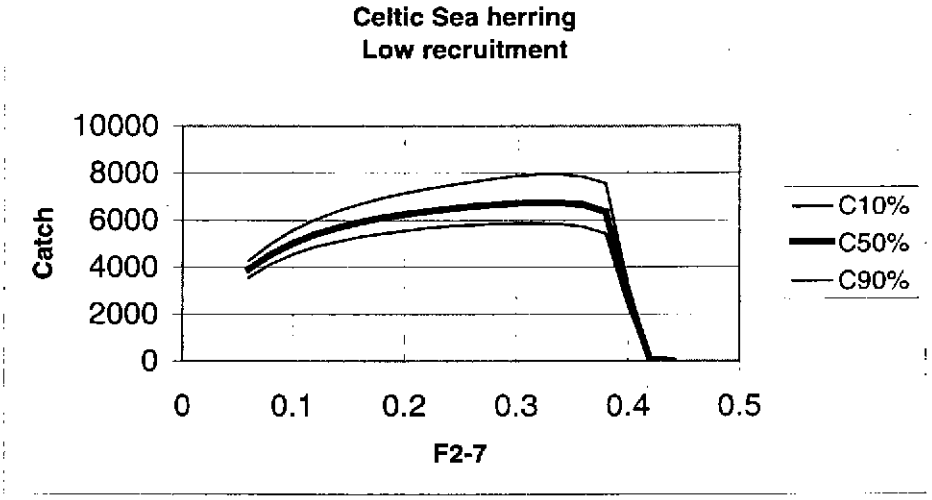


Figure 4.7.1
Long term equilibrium SSB and Catch distributions with stochastic recruitment
Lower panel: Risk that SSB is below the limits indicated.





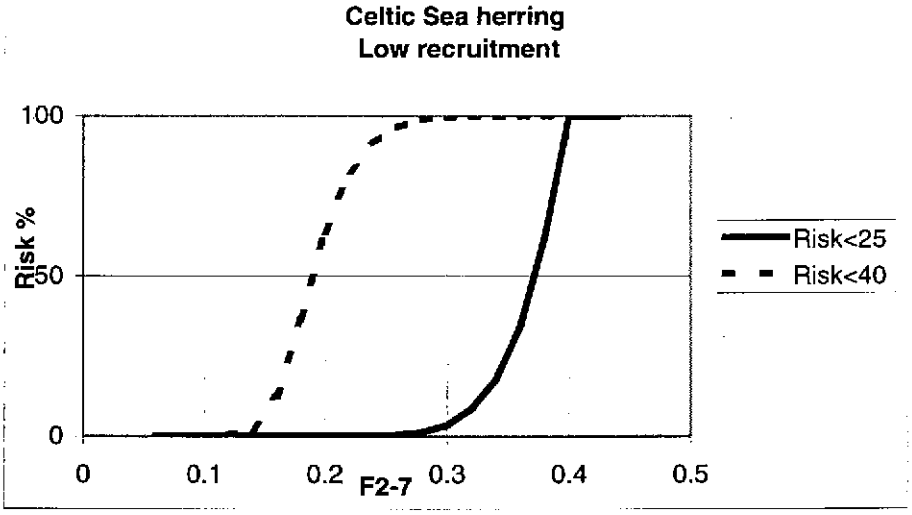


Figure 4.7.2
Long term equilibrium SSB and Catch distributions with stochastic recruitment
Lower panel: Risk that SSB is below the limits indicated.

5 WEST OF SCOTLAND HERRING

5.1 Division VIa(North)

5.1.1 ACFM Advice Applicable to 1998 and 1999

ACFM reported in 1998 that the state of the stock was uncertain because indicators of stock status provide conflicting signals and because the catch data are unreliable. The available indicators suggested that the increased catches estimated for 1997 had resulted in an increase in fishing mortality which was unlikely to be sustainable. In consequence, ACFM recommended that catches in 1999 should not exceed the average catch of the 1991–1996 period, which was about 28,000 t.

The agreed TAC for 1999 is 68,000 t compared with a TAC in 1998 of 80,370 t.

There are no explicit management objectives for this stock, and because of uncertainties about the historical catch data, the size of the biomass and about estimates of recruitment and fishing mortality, no biological reference points have been proposed for this stock.

5.1.2 The Fishery

Catches are taken from this area by three more or less distinct fisheries. The Scottish domestic pair trawl fleet operates in shallower, coastal areas, principally fishing in the Minches and around the Island of Barra in the South. Younger herring are found in these areas. The Scottish and Norwegian Purse Seine fleets target herring mostly in the Northern North Sea, but also operate in the Northern part of VIa(N). An international freezer-trawler fishery has historically operated in deeper water near the shelf edge where older fish are distributed. These vessels are mostly registered in the Netherlands, Germany, France and England.

As a result of perceived problems of misreporting, a new fishery regulation was introduced by Scotland in 1997 with the intention of improving reporting accuracy. Under this regulation, Scottish vessels fishing for herring were required to hold a license either to fish in the North Sea or in the West of Scotland Area. Only one of these options could be held at any one time. During the months of the peak of the Shetland fishery, vessels requiring West Coast licenses were required to collect them from West Coast ports, and *vice versa* for the North Sea.

5.1.3 Landings Estimates and Allocation of Catches to Area

Serious problems with misreporting of catches from this stock have occurred in the past, with many examples of vessels operating and landing herring catches distant from VIa(N) but reporting catches from that area. Fishery-independent information confirmed that large catches were being reported from areas with low abundances of fish, and informal information from the fishery and from other sources confirmed that most catches of fish recorded between 4°W and 5°W were most probably misreported North Sea catches. The problem was particularly acute during the peak months of the Shetland herring fishery (August to October). Such misreporting was believed to have been significant since 1984, but the extent to which a different licensing scheme introduced in 1997 restricted the opportunities for such misreporting is unknown.

For 1997, the Working Group in 1998 considered that due to the unknown effectiveness of the new restrictions, uncertainty existed in the catches in the range 30,165 t to 64,995 t. Although new information suggests (contrary to previous opinion) that the extent of misreporting in 1997 may not have been greatly different from that in previous years, this uncertainty in the 1997 catches persists.

For 1998, the preliminary reports of official catches corresponding to the VIa(N) herring stock unit total 77,501 t compared with the TAC of 80,370 t. The Working Group's estimates of unallocated catches are 44,148 t. Of this, 32,446 t are specifically attributed to catches of herring caught in Division IVa by various nations but reported in the area between 4° and 5°W in VIa(N). The totals include 28 t of spring-spawning herring reported by the Netherlands, and 15 t of herring reported caught by Scotland in Division Vb. A further 90 t of herring has been reported as discarded.

The Working Group's best estimate of removals from the stock in 1998 is 33,353 t. Details of estimated catches from 1970 to 1998 are given in Table 5.1.1.

5.1.4 Age-Composition of Commercial Catches

Age composition data for the commercial catches for 1998 were available from Scotland (quarters 3 and 4), Germany (quarter 3), Netherlands (quarters 1 and 3), and Norway. Reported age-structured data are given in Table 5.1.2. by country and by quarter. Unsampled catches were allocated a mean age-structure (weighted by the sampled catch) of all sampled fleets in the same quarter, or in adjacent quarters if no samples were available in the corresponding quarter. Full details of catch sampling, the allocation of age-structures to unsampled catches, and the calculation of total international catch at age and mean weight at age in the catches are given in Table 5.1.3. This calculation was made using the 'sallocl' programme (Patterson, 1998).

A summary of sampling information is given in Table 5.1.3. The number of samples used to allocate an age-distribution for the Scottish catches declined from 18 in 1997 to 12 in 1998, and the number of samples available from the offshore freezer-trawl fishery increased from 8 to 43.

New and historic catch in number information is given in Table 5.1.4.

5.1.5 Larvae Surveys

Larvae surveys for this stock have been discontinued since 1994. The historical time-series will however be used in assessment model fitting and has been reproduced for convenience (Table 5.1.5.). Documentation of this survey time-series is given in ICES (1994a).

5.1.6 Acoustic Survey

The survey in 1997 recorded an unexpectedly low estimate of abundance. Interpretation of survey results is not straightforward because the survey was completed one month earlier than other surveys in the historical time-series. Therefore, the 1997 survey has been excluded from the stock assessment calculation.

Details of the 1998 survey are given in Section 2.4. Estimates of abundance by age and in aggregate biomass for 1998 and for previous years are given in Table 5.1.6.

5.1.7 Mean Weights at Age

Weights at age in the catches and from acoustic surveys are given in Table 5.1.7. Due to the different timing of the acoustic survey in 1997 the new estimates of weight at age in the stock in that year are not consistent with previous estimates (Table 5.1.7). In order to maintain historically-consistent estimates of spawning biomass, these values were not used for assessment purposes and instead mean values over the period 1992 to 1996 were used for 1997.

The basis for calculation of weights at age in the catches is given in Tables 5.1.2 and 5.1.3. Catch weights are lower in 1998 than in previous years, because samples were available from the fishery in the first quarter whereas in previous years sampling has been concentrated in the third quarter.

5.1.8 Maturity Ogive

The earlier timing of the acoustic survey in 1997 also occasioned lower values of maturity to be recorded (Table 5.1.8). As for the weights at age, these values were not used for assessment purposes and a mean value over the years 1992–1996 was used for 1997 and for years prior to 1991. For 1998, values consistent with the historic time-series are available and are tabulated.

5.1.9 Data Exploration and Preliminary Modelling

Considerable data exploration was carried out by Simmonds *et. al.* (1998b). This report indicated that:

- There is an inconsistency between the age-structure information in the acoustic surveys and in the commercial catches.

- The abundance of older fish in the acoustic surveys appears to have declined, and the reason for this is not obvious.

- Exploitation by two fleets with different selection patterns and in different geographical areas yet with limited sampling on both may render problematic the interpretation of age-structure information from the commercial catches and the use of a constant selection pattern in the model.

Various approaches were used to attempt to reconcile these features of the data (use of XSA, use of age-aggregated survey information) with little apparent success. It is clear that, in addition to quantifiable uncertainty, a great deal of model uncertainty is associated to estimates of stock size and fishing mortality. This is of course in addition to the already large uncertainty introduced by the uncertainty about the actual level of commercial catches taken from the area.

Despite these problematic features, the Working Group has failed to identify an assessment model better suited to the assessment of this stock than that used previously. In consequence, the assessment procedure used at the 1998 Working Group meeting was repeated.

5.1.10 Stock Assessment

5.1.10.1 Assessment Model

The structural model used for the assessment is virtually unchanged from that used in the previous year. Uncertainty was assessed using a Bayesian calculation including the uncertainty in the amount of catches taken in the area between 4°-5°W. The 1997 acoustic survey was excluded from the data set (see Section 5.1.6). As noted above, the uncertainty calculation does not include uncertainty introduced by the violation of structural assumptions (which are thought may exist; see Section 5.1.8.) and by the contamination of age-structure information with data from samples of North Sea origin.

Defining:

a,y	age and year subscripts
C	Catch in number at age and year
C'	Catch in number at age and year predicted by a separable fishing model
SSB	Spawning stock size in the structural model
LAI	Larval abundance index
ACOUST	Acoustic Survey estimates of abundance at age
N	Population abundance in the structural model
SSB	Spawning stock biomass in the structural model
Q_{LAI}	Coefficient of proportionality for larvae survey estimates of stock abundance
Q_{ACU}	Coefficient of proportionality for acoustic survey estimates of stock abundance
K	Power coefficient for the LAI estimate of stock abundance
λ	Variance of the observations (assumed equal for all observations).

The least-squares component of the likelihood function used in the assessment is:

$$\sum_{a,y}(\ln(C_{a,y}) - \ln(C'_{a,y}))^2 / \lambda +$$
$$\sum_{y}(\ln(Q_{LAI} SSB_y^K) - \ln(LAI_y))^2 / \lambda +$$
$$\sum_{a,y}(\ln(Q_{ACU,a} N_{a,y}) - \ln(ACOUST_{a,y}))^2 / \lambda$$

A Bayes Markov-Chain Monte Carlo calculation was initiated based on the model described above, with the same data, parameterisation and likelihood function except that two additional parameters were included:

1. a scaling of the catch in numbers in 1997 with uniform prior probability in the range (1, 0.464) where 0.464 = (64995 - 30165)/64995. The catch estimates of 64995 and 30165 represent the upper and lower bounds of plausible catches in 1997. The working group has no grounds for assigning higher probabilities to any of the figures in this range, and for that reason a uniform prior was specified.

2. The variance, λ, of the log residuals for all observations, with prior probability proportional to the reciprocal of the variance (i.e., $P(\lambda) \propto 1/\lambda$). Including this as a parameter is similar in principle to estimating a sum of squares in a minimisation.

For all other parameters, a uniform, unrestrictive prior distribution of the log-transformed parameters was assumed, i.e., uniform distribution of log (F), log (N) etc. This corresponds to the conventional parameterisation, but the extent to which this specification of prior distributions may be informative with respect to stock biomass or fishing mortality has not yet been investigated.

Expected values and percentiles of yield, historic stock size, fishing mortality and recruitments so calculated are given in Table 5.1.9 and Figure 5.1.1.

The ICA v1.4 software was used with a modification to include these extra parameters and prior assumptions. As previously, the chain was run with burn-in period of 1000 iterations and samples were taken at intervals of 400 iterations. No formal evaluation of the sufficiency of the burn-in period and of the thinning interval was made, but the sequence of spawning stock size and fishing mortality estimates drawn from the chain is shown in Figure 5.1.2. Although some correlations appear to persist (indicating that it may have been preferable to run the chain for longer, with a longer thinning interval), there is no evidence of failure to converge. The chain was run for 401 000 iterations, hence the tabulated percentiles are based on 1000 samples of parameter values.

With the addition of new survey data in 1998 the assessment of the stock is rather more precise than was estimated previously. New estimates of the 90% confidence interval for fishing mortality in 1998 are from 0.18 to 0.65, compared with a 90% interval from 0.13 to 1.83 that was estimated for 1997 by the Working Group in 1998. Similarly, new estimates of spawning biomass in 1998 are from 50,000 to 215,000 with 90% confidence, compared with the range from 19,000 to 309,000 t estimated previously for 1997.

Inferences from the posterior estimates of catches in 1997 are revised from 50,000 t to 40,000 t, and this tends to confirm opinions drawn on the basis of improved knowledge of fishery operations. However, the precision of this estimate is low (36,000 to 64,000 t with 90% confidence).

In order to assess the precision with which trends in stock size can be inferred, probability distributions for fishing mortality and stock size in 1997 - 1998 relative to fishing mortality and stock size in the previous five years are shown at the bottom of Table 5.1.9. Despite the imprecision in the assessment, it appears likely that stock size has declined recently ($P > 0.75$) and fishing mortality has increased ($P > 0.75$).

5.1.10.2 Assessment Diagnostics

Because of the stochastic nature of the Bayesian assessment it is not straightforward to evaluate residual trends, and therefore a maximum-likelihood fit is provided for this purpose (Table 5.1.10 and Figures 5.1.3–5.1.15). Here, landings and catch numbers for 1997 have been calculated from the value taken from the mean of the posterior distribution calculated in the foregoing, and equal to 40,324 t. A log of ICA run choices is given in Table 5.1.11. The maximum-likelihood parameter estimates so calculated do not necessarily correspond to the means of the Bayes posteriors in cases where the data are only weakly informative, as appears to be the case here.

The residual trends so calculated are in the same direction, but slightly weaker than those noted in Section 5.1.9. Quite strong negative residuals appear at older ages of the acoustic survey in 1998 and at most ages in 1996. Residuals at age 4 and younger in 1998 are positive. This indicates that there are fewer observations of older fish in the acoustic survey than would be expected from the calculated catches at age under the assumption that selection is stable. The reasons for this discrepancy are unknown.

5.1.11 Short term projections

5.1.11.1 Deterministic short-term projections

Due to uncertainty in the assessment it has not been considered appropriate to provide deterministic short-term projections.

5.1.11.2 Stochastic short-term projections

Percentiles of the posterior probability distributions for yield, fishing mortality and stock size have been tabulated subject to a number of constraints and assumptions. These assumptions and constraints are described below. The method used to calculate these distributions is to:

1. Draw one set of parameters from the posterior distribution in the assessment and recalculate all the historic population estimates.

2. Beginning with the complete historic set of parameter estimates, calculate the catch forecast and stock biomass in the conventional way, subject to F and catch constraints, etc.

3. Repeat the calculation for all the 1000 draws calculated in the MCMC process.

4. Sort and tabulate the percentiles of the values of catch, fishing mortality and spawning stock biomass so obtained.

The assumptions and constraints used for the short-term projections were as follows (See also Table 5.1.14):

- Fishing mortality in 1999 was assumed equal to the estimated fishing mortality in 1998;

- Starting population numbers on 1 January 1999 were taken from posterior distribution of the population model parameters, except for fish aged 1 and 2, for which an abundance was calculated using a geometric mean recruitment at age 1 over the period 1986 to 1996, and using the estimated fishing mortality at age 1 in 1998;

- Historic mean weights at age in the stock from 1994 to 1998 were used for stock weights;

- Historic mean weights at age in the catch from 1994 to 1998 were used for catch weights;

- An arithmetic mean historic maturity from 1994 to 1998 was used in the projections.

- The exploitation pattern used for the projections was taken from the posterior distribution of population model parameter estimates.

- In the absence of a usable stock-recruit relationship, short-term forecasts are made on the basis that recruitments in 1998 and 1999 are equal to the geometric mean of the recruitments from 1976–1996.

Input data for the projections are given in Table 5.1.12. 'ICP' software was used to calculate the projections from parameter values drawn from the Bayes posterior distribution. All projections are made for an F status quo assumption in 1998 and for a range of catch options in 1999. Expectations and the 25 th, 50 th and 75 th percentiles of the corresponding estimates of spawning stock size and fishing mortality are tabulated in Table 5.1.13.

5.1.12 Medium-Term Projections

The same method was used as for the short-term projections. Medium-term projections were initiated from draws from the Bayesian posterior parameter distributions and are provided for the case of constant fishing mortality at the 1998 level. Projection options chosen are as detailed in Section 5.1.10.2. Recruitments for 1999 and later were modelled on the assumption that if the spawning biomass should fall below the lowest observed level, then a decline in recruitment would occur that would be linear from the geometric mean of the 1976–1996 year-classes at the lowest observed stock size, to zero recruitment at zero spawning biomass. Interannual variability in recruitment around this structural model was represented by a nonparametric bootstrap method on log-transformed residuals. The resultant projection is given in Figure 5.1.16.

5.1.13 Comments on the Assessment

The assessment provided here may serve to characterise a significant part of the uncertainty in stock size estimates, being that due to stochastic noise in the surveys, in the catches at age, and in the landings in 1997. However, other uncertainties that may be important have not been quantified, among which:

- Violation of the structural model assumption, as apparent in residual trends;

- Uncertainty in catches in years other than 1997, which may also be significant;

- Uncertainties in natural mortality, maturity and growth.

- Contamination of the age-structure of the catches with samples incorrectly allocated from Division IVa.

5.1.14 Management Considerations

The assessment is improved compared with that calculated previously due to the addition of a new survey in 1998, and improved sampling of the catches, but it is still imprecise. Uncertainty in the state of the stock arises because the catch data are very unreliable for 1997, the survey in 1997 is unusable due to altered timing, and there is concern about contamination of biological information with data from the adjacent IVa area. Additional uncertainty is introduced by apparent violations of the structural model. Quantified uncertainty indicates the 90% confidence intervals for fishing mortality in 1998 are at least as wide as the range 0.11 to 0.65 and for spawning stock biomass, in the range 50,000 to 95,000 t. These ranges span values corresponding to both light exploitation and fishing at unsustainably high fishing mortalities.

Subject to the above caveats, it is estimated that catches exceeding 42,000 t in 2000 have a rather high probability (> 50%) of resulting in a fishing mortality greater than the value of $F = 0.25$ that is currently considered to be precautionary for the North Sea stock (Table 5.1.13).

Despite the uncertainty in the present state of the stock, it appears likely that fishing mortality has increased in the last two years compared with the preceding five years, and similarly that spawning stock biomass has declined over the same period.

5.2 Clyde Herring

5.2.1 Advice and management applicable to 1998 and 1999

Management of herring in the Clyde is complicated by the presence of two virtually indistinguishable stocks; a resident spring-spawning population and the immigrant autumn-spawning component. In recent years management strategies have been directed towards rebuilding the highly depleted spring-spawning component to historical levels.

The measures which remain in force in order to protect the indigenous spring-spawning stock are:

- A complete ban on herring fishing from 1 January to 30 April;
- A complete ban on all forms of active fishing from 1 February to 1 April, on the Ballantrae Bank spawning grounds, to protect the demersal spawn and prevent disturbance of the spawning shoals;
- A ban on herring fishing between 00:00 Saturday morning and 24:00 Sunday night;
- The TACs in 1998 and 1999 were maintained at the same level as in recent years (1,000 tonnes).

5.2.2 The fishery in 1998

Annual landings from 1955 to 1998 are presented in Table 5.2.1. Landings in 1998 were 992 t which were the highest since 1990. Landings by the local fleet were 779 t whilst a total of 213 t were taken by Northern Ireland vessels landing into Northern Ireland. This is the third consecutive year, since 1985 that landings from non-local vessels have been reported. Most of the landings were in the third and fourth quarters of the year. The proportions of spring and autumn spawners in these landings could not be estimated.

The sampling levels of the local fishery have been reduced in recent years but are still well above recommended levels (Table 5.2.2). Samples were taken from the Scottish fleets only.

5.2.3 Weight at age and stock composition

The catch in numbers at age for the period 1970 to 1998 is given in Table 5.2.3. The catches of age 2 fish have increased over the last six years. The strong 1993 year class, reported in previous reports, is not apparent in the 1998 catches. Catches of the 1995 and 1996 year classes appear high, with the highest catches of age 3 fish since 1989 being recorded.

Weights at age are given in Table 5.2.4. Mean weights in the stock have not been available from research vessel surveys since 1991, therefore the weights in the stock used are the weights at age in the catches.

Once again no attempt has been made to apportion catches between spring and autumn-spawning stocks for 1998. The majority of landings were in the last two quarters suggesting that the fishery was based on the autumn spawners. The small landings in the first half of the year (0.2 t) are mainly taken as by-catch in the demersal trawl fishery.

An index of effort (E), based solely on the Scottish trawler fleet assuming similar catchability between gears, has been calculated for comparison with previous years as follows;

$$E = E_p . L / L_p$$

Where E_p = days absent by Scottish pair trawlers.

L = total landings in tonnes.

L_p = landings by pair trawlers in tonnes.

This shows a large increase in the last two years (Table 5.2.5).

5.2.4 Surveys

No demersal egg surveys on the Ballantrae Bank and Brown Head spawning sites, no acoustic surveys in the Clyde and no spring trawl surveys were carried out in 1998. Historical estimates from these surveys are tabulated in (ICES 1995 Assess:13).

5.2.5 Stock Assessment

The structure of the stock in the Clyde remains uncertain. There is considerable uncertainty in the CPU estimates when the effort is so low and area misreporting may be occurring. No survey data are available from recent years therefore no analytical assessment could be attempted.

5.2.6 Stock and catch projections

In the absence of an analytical assessment no stock projections can be provided.

5.2.7 Management considerations

The management of this fishery is made difficult by the presence of a mixture of a severely depleted spring-spawning component and autumn spawners from Division VIa south. The management objectives for these two components are necessarily distinct. The absence of fishery independent data from surveys further compounds the problem.

Historically the spring spawning stock supported a fishery with catches up to 15,000 tonnes per year in the 1960's. Landings generally began to decline through the 1970's and 1980's with a rapid decline in effort during the late 1980's up to the present time. A TAC was first set in 1984 (3,000 t) increasing to a maximum of 3,500 tonnes in 1987 subsequently decreasing to 1,000 tonnes by 1993. Estimated catches, including discards, exceeded the TAC for the first four years. This was followed by a decline in catches to 1990. In 1991 there was a dramatic drop in both landings and effort and since then landings have fluctuated at below 1,000 tonnes.

In the absence of surveys and no stock separation of the catches, nothing is currently known about the state of the spring spawning stock. All the management measures, currently in force, need to remain. Catches should be reduced to as low a level as possible and an attempt should be made to apportion those catches to spring and autumn spawning components.

Table 5.1.1. HERRING in Division VIa (North). Catch in tonnes by country, 1970-1997. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1970	1971	1972	1973	1974	1975
Denmark	0	554	150	932	0	374
Faroes	15100	8100	8094	10003	5371	3895
France	1293	2055	680	2441	411	1244
Germany	11768	6444	3376	9914	8887	6182
Iceland	5595	5416	2066	2532	9566	2633
Netherlands	464	8340	22673	27892	17461	12024
Norway	27250	76721	17400	32557	26218	509
UK	103530	99537	107638	120800	107520	85520
Other	930		2679	3199	2726	1620
Unallocated						
Discards						
Total	165930	207167	164756	210270	178160	114001
Area-Misreported						
WG Estimate	**165930**	**207167**	**164756**	**210270**	**178160**	**114001**
Source (WG)	1982	1982	1982	1982	1982	1982

Country	1976	1977	1978	1979	1980	1981
Denmark	249	626	128	0	0	1580
Faroes	4017	3564	0	0	0	0
France	1481	1548	1435	3	2	1243
Germany	4363	0	26	0	256	3029
Iceland	3273	0	0	0	0	0
Netherlands	16573	8705	5874	0	0	5602
Norway	5183	1098	4462	57	0	3850
UK	53371	25539	10231	0	48	31483
Other	5132	261				
Unallocated						4633
Discards						
Total	93642	41341	22156	60	306	51420
Area-Misreported						
WG Estimate	**93642**	**41341**	**22156**	**60**	**306**	**51420**
Source (WG)	1982	1982	1982	1982	1982	1983

Country	1982	1983	1984	1985	1986	1987
Denmark	0	0	96	0	0	0
Faroes	74	834	954	104	400	0
France	2069	1313	0	20	18	136
Germany	8453	6283	5564	5937	2188	1711
Ireland	0	0	0	0	6000	6800
Netherlands	11317	20200	7729	5500	5160	5212
Norway	13018	7336	6669	4690	4799	4300
UK	38471	31616	37554	28065	25294	26810
Other						
Unallocated	18958	-4059	16588	-502	37840	18038
Discards	0	0	0	0	0	0
Total	**92360**	**63523**	**75154**	**43814**	**81699**	**63007**
Area-Misreported			-19142	-4672	-10935	-18647
WG Estimate	**92360**	**63523**	**56012**	**39142**	**70764**	**44360**
Source (WG)	1984	1985	1986	1987	1988	1989

Table 5.1.1. cont...

Country	1988	1989	1990	1991	1992	1993
Denmark	0	0	0	0	0	0
Faroes	0	0	326	482	0	0
France	44	1342	1287	1168	119	818
Germany	1860	4290	7096	6450	5640	4693
Ireland	6740	8000	10000	8000	7985	8236
Netherlands	6131	5860	7693	7979	8000	6132
Norway	456	0	1607	3318	2389	7447
UK	26894	29874	38253	32628	32730	32602
Other						
Unallocated	5229	2123	2397	-10597	-5485	-3753
Discards	0	1550	1300	1180	200	
Total	47354	53039	69959	50608	51578	56175
Area-Misreported	-11763	-19013	-25266	-22079	-22593	-24397
WG Estimate	**35591**	**34026**	**44693**	**28529**	**28985**	**31778**
Source (WG)	1990	1991	1992	1993	1994	1995

Country	1994	1995	1996	1997	1998
Denmark	0	0	0	0	0
Faroes	0	0	0	0	0
France	274	3672	2297	3093	1903
Germany	5087	3733	7836	8873	8253
Ireland	7938	3548	9721	1875	11199
Netherlands	6093	7808	9396	9873	8483
Norway	8183	4840	6223	4962	5317
UK	30676	42661	46639	44273	42302
Other					
Unallocated	-4287	-4541	-17753	-8015	-11748
Discards	700			62	90
Total	54664	61721	64359	64995	65799
Area-Misreported	-30234	-32146	-38254	-5039	-32446
WG Estimate	24430	29575	26105	59957	33353
Source (WG)	1996	1997	1997	1998	**New Data**

Other: Official catches by countries other than those named. Unallocated: Catches for which the Working Group has specific reports of an under- or over-reporting of catches. Discards: Estimates of fish discarded or slipped, usuallly from observer records. Area-Misreported: Catches reported in the area beteeen 4 and 5 W and reallocated to IVa.

Table 5.1.2. Herring in VIa(N). National sampling, reported catches and summary of biological data

a. Catch in Number at age

Country	Quarter	Area & Stock	Sampled Catch (t)	Official Catch (t)	No. of samples	No. fish aged	No. fish measured	Catch in Number at Age (Thousands) 0	1	2	3	4	5	6	7	8	9
England & Wales	1	VIa(N)	0	247	0	0	0	0	0	0	0	0	0	0	0	0	0
England & Wales	2	VIa(N)	0	77	0	0	0	0	0	0	0	0	0	0	0	0	0
England & Wales	3	VIa(N)	0	1142	0	0	0	0	0	0	0	0	0	0	0	0	0
England & Wales	4	VIa(N)	0	685	0	0	0	0	0	0	0	0	0	0	0	0	0
France	1	VIa(N)	0	0.024	0	0	0	0	0	0	0	0	0	0	0	0	0
France	3	VIa(N)	0	1903.498	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	1	VIa(N)	0	342	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	2	VIa(N)	0	1536	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	3	VIa(N)	4428	4428	30	88	1155	0	0	330	1160	9030	5667	3092	2018	389	377
Germany	4	VIa(N)	0	1947	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	3	VIa(N)	0	11199	0	0	0	0	0	0	0	0	0	0	0	0	0
N. Ireland	3	VIa(N)	0	733	0	0	0	0	0	0	0	0	0	0	0	0	0
N. Ireland	4	VIa(N)	0	95	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	1	VIa(N)-SS	26	27.97194	4	564	100	0	0	0	0	0	9	27	36	27	0
Netherlands	1	VIa(N)	306	329.2082	4	100	564	0	0	0	395	601	239	464	159	260	326
Netherlands	3	VIa(N)	7579	8153.82	5	552	125	0	0	3675	8574	7962	8268	5512	3062	612	612
Norway	2	VIa(N)	4777	4777	2	125	125	0	0	11232	7712	9221	2682	1676	671	0	0
Norway	3	VIa(N)	0	540	0	0	0	0	0	0	0	0	0	0	0	0	0
Scotland	1	VIa(N)	0	443	0	0	0	0	0	0	0	0	0	0	0	0	0
Scotland	2	VIa(N)	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0
Scotland	3	VIa(N)	7743	35454	3	283	790	0	3862	37773	7155	1762	532	127	236	0	137
Scotland	4	VIa(N)	2943	3402	9	778	2082	0	1791	8991	4921	2401	1478	546	465	169	248
Scotland	1	Vb	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0
Total				**77500.5**													

b. Mean Weights at Age

Country	Qtr	Area & Stock	Sampled Catch (t)	Official Catch (t)	No. of samples	No. fish aged	No. fish measured	Mean Weight at Age in the Catches (Kg) 0	1	2	3	4	5	6	7	8	9
England & Wales	1	VIa(N)	0	247	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
England & Wales	2	VIa(N)	0	77	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
England & Wales	3	VIa(N)	0	1142	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
England & Wales	4	VIa(N)	0	685	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	1	VIa(N)	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	3	VIa(N)	0	1903	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	1	VIa(N)	0	342	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	2	VIa(N)	0	1536	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	3	VIa(N)	4428	4428	30	88	1155	0.00	0.00	0.12	0.17	0.18	0.20	0.24	0.24	0.23	0.26
Germany	4	VIa(N)	0	1947	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	3	VIa(N)	0	11199	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N. Ireland	3	VIa(N)	0	733	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N. Ireland	4	VIa(N)	0	95	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1	VIa(N)-SS	26	28	4	564	100	0.00	0.00	0.00	0.00	0.00	0.20	0.27	0.27	0.28	0.00
Netherlands	1	VIa(N)	306	329	4	100	564	0.00	0.00	0.00	0.11	0.12	0.13	0.13	0.13	0.14	0.14
Netherlands	3	VIa(N)	7579	8154	5	552	125	0.00	0.00	0.14	0.17	0.20	0.21	0.23	0.24	0.29	0.24
Norway	2	VIa(N)	4777	4777	2	125	125	0.00	0.00	0.12	0.15	0.15	0.17	0.20	0.21	0.00	0.00
Norway	3	VIa(N)	0	540	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scotland	1	VIa(N)	0	443	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scotland	2	VIa(N)	0	24	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scotland	3	VIa(N)	7743	35454	3	283	790	0.00	0.11	0.15	0.17	0.20	0.22	0.26	0.24	0.00	0.26
Scotland	4	VIa(N)	2943	3402	9	778	2082	0.00	0.08	0.12	0.15	0.17	0.18	0.20	0.20	0.20	0.22

c. Mean Lengths at Age

Country	Qtr	Area	Sampled	Official	No. of	No. fish	No. fish	Mean Weight at Age in the Catches (Kg)									
0	0	& Stock	Catch	Catch	samples	aged	measured	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	0	0	(t)	(t)	0	0	0										
England & Wales	1	VIa(N)	0	247	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
England & Wales	2	VIa(N)	0	77	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
England & Wales	3	VIa(N)	0	1142	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
England & Wales	4	VIa(N)	0	685	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	1	VIa(N)	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	3	VIa(N)	0	1903	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	1	VIa(N)	0	342	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	2	VIa(N)	0	1536	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	3	VIa(N)	4428	4428	30	88	1155	0.00	0.00	252.60	280.14	288.53	294.77	312.32	313.26	312.54	322.76
Germany	4	VIa(N)	0	1947	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	3	VIa(N)	0	11199	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N. Ireland	3	VIa(N)	0	733	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N. Ireland	4	VIa(N)	0	95	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1	VIa(N)-SS	26	28	4	564	100	0.00	0.00	0.00	0.00	0.00	287.50	309.20	316.30	317.50	0.00
Netherlands	1	VIa(N)	306	329	4	100	564	0.00	0.00	0.00	254.00	266.00	276.00	282.00	283.00	284.00	286.00
Netherlands	3	VIa(N)	7579	8154	5	552	125	0.00	0.00	248.30	269.60	281.00	288.20	295.60	301.00	322.50	305.00
Norway	2	VIa(N)	4777	4777	2	125	125	0.00	0.00	116.60	150.50	148.80	169.40	201.30	213.00	0.00	0.00
Norway	3	VIa(N)	0	540	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scotland	1	VIa(N)	0	443	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scotland	2	VIa(N)	0	24	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scotland	3	VIa(N)	7743	35454	3	283	790	0.00	225.00	248.00	260.00	274.00	286.00	300.00	290.00	0.00	299.39
Scotland	4	VIa(N)	2943	3402	9	778	2082	0.00	220.00	248.00	265.00	278.00	284.00	296.00	299.00	297.00	304.26

Table 5.1.3. Herring in VIa(N). Catch and sampling effort by nation participating in the fishery, allocation of age-structures to unsampled catches ('fill-in rules') and estimates of catch in number, mean weight at age and mean length at age. 'VIa(N)-SS' refers to spring-spawning herring reported caught in VIa(N), but included in the stock unit for the purposes of this calculation. 'Periods 1-4' refer to quarters of the year. Output generated by the programme 'SALLOCL' (see Patterson, WD 1998)

Summary of Sampling by Country

AREA : VIa(N)

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged		SOP %
England & Wales	0.00	2151.00	0	0	0	0.00	
France	0.00	1903.52	0	0	0	0.00	
Germany	4428.00	8253.00	30	1155	88	99.73	
Ireland	0.00	11199.00	0	0	0	0.00	
N. Ireland	0.00	828.00	0	0	0	0.00	
Netherlands	7885.00	8483.03	9	689	652	99.89	
Norway	4777.00	5317.00	2	125	125	100.00	
Scotland	10686.00	39323.00	12	2872	1061	99.99	
Total VIa(N)	27776.00	77457.55	53	4841	1926	99.92	

Sum of Offical Catches : 77457.55
Unallocated Catch : -44145.53
Working Group Catch : 33312.02

AREA : VIa(N)-SS

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged		SOP %
Netherlands	26.00	27.97	4	100	564	101.67	
Total VIa(N)-SS	26.00	27.97	4	100	564	101.67	

Sum of Offical Catches : 27.97
Unallocated Catch : -1.97
Working Group Catch : 26.00

AREA : Vb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged		SOP %
Scotland	0.00	15.00	0	0	0	0.00	
Total Vb	0.00	15.00	0	0	0	0.00	

Sum of Offical Catches : 15.00
Unallocated Catch : 0.00
Working Group Catch : 15.00

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged		SOP %
England & Wales	0.00	247.00	0	0	0	0.00	
France	0.00	0.02	0	0	0	0.00	
Germany	0.00	342.00	0	0	0	0.00	
Netherlands	332.00	357.18	8	664	664	100.42	
Scotland	0.00	458.00	0	0	0	0.00	
Period Total	332.00	1404.20	8	664	664	100.42	

Sum of Offical Catches : 1404.20
Unallocated Catch : -125.18
Working Group Catch : 1279.02

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged		SOP %
England & Wales	0.00	77.00	0	0	0	0.00	
Germany	0.00	1536.00	0	0	0	0.00	
Norway	4777.00	4777.00	2	125	125	100.00	

Table 5.1.3. Continued

Scotland	0.00	24.00	0	0	0	0.00
Period Total	4777.00	6414.00	2	125	125	100.00

Sum of Offical Catches : 6414.00
Unallocated Catch : -4777.00
Working Group Catch : 1637.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged		SOP %
England & Wales	0.00	1142.00	0	0	0	0.00	
France	0.00	1903.50	0	0	0	0.00	
Germany	4428.00	4428.00	30	1155	88	99.73	
Ireland	0.00	11199.00	0	0	0	0.00	
N. Ireland	0.00	733.00	0	0	0	0.00	
Netherlands	7579.00	8153.82	5	125	552	99.87	
Norway	0.00	540.00	0	0	0	0.00	
Scotland	7743.00	35454.00	3	790	283	99.99	
Period Total	19750.00	63553.32	38	2070	923	99.89	

Sum of Offical Catches : 63553.32
Unallocated Catch : -39972.82
Working Group Catch : 23580.50

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged		SOP %
England & Wales	0.00	685.00	0	0	0	0.00	
Germany	0.00	1947.00	0	0	0	0.00	
N. Ireland	0.00	95.00	0	0	0	0.00	
Scotland	2943.00	3402.00	9	2082	778	100.01	
Period Total	2943.00	6129.00	9	2082	778	100.01	

Sum of Offical Catches : 6129.00
Unallocated Catch : 727.50
Working Group Catch : 6856.50

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged		SOP %
England & Wales	0.00	2151.00	0	0	0	0.00	
France	0.00	1903.52	0	0	0	0.00	
Germany	4428.00	8253.00	30	1155	88	99.73	
Ireland	0.00	11199.00	0	0	0	0.00	
N. Ireland	0.00	828.00	0	0	0	0.00	
Netherlands	7911.00	8511.00	13	789	1216	99.89	
Norway	4777.00	5317.00	2	125	125	100.00	
Scotland	10686.00	39338.00	12	2872	1061	99.99	
Total for Stock	27802.00	77500.52	57	4941	2490	99.92	

Sum of Offical Catches : 77500.52
Unallocated Catch : -44147.50
Working Group Catch : 33353.02

DETAILS OF DATA FILLING-IN

Filling-in for record : (1) England & Wales 1 VIa(N)
Mean Weighted by Sampled Catches of:
>> (14) Netherlands 1 VIa(N)-SS
>> (15) Netherlands 1 VIa(N)

Filling-in for record : (2) England & Wales 2 VIa(N)
Mean Weighted by Sampled Catches of:
>> (14) Netherlands 1 VIa(N)-SS
>> (15) Netherlands 1 VIa(N)

Table 5.1.3. Continued

```
  >>  (  9)  Germany                3 VIa(N)
  >>  ( 16)  Netherlands            3 VIa(N)
  >>  ( 21)  Scotland               3 VIa(N)

  Filling-in for record : (  3)   England & Wales        3 VIa(N)
Mean Weighted by Sampled Catches of:
  >>  (  9)  Germany                3 VIa(N)
  >>  ( 16)  Netherlands            3 VIa(N)
  >>  ( 21)  Scotland               3 VIa(N)

  Filling-in for record : (  4)   England & Wales        4 VIa(N)
Using Only
  >>  ( 22)  Scotland               4 VIa(N)

  Filling-in for record : (  5)   France                 1 VIa(N)
Mean Weighted by Sampled Catches of:
  >>  ( 14)  Netherlands            1 VIa(N)-SS
  >>  ( 15)  Netherlands            1 VIa(N)


  Filling-in for record : (  6)   France                 3 VIa(N)
Mean Weighted by Sampled Catches of:
  >>  ( 14)  Netherlands            1 VIa(N)-SS
  >>  ( 15)  Netherlands            1 VIa(N)
  >>  (  9)  Germany                3 VIa(N)
  >>  ( 16)  Netherlands            3 VIa(N)
  >>  ( 21)  Scotland               3 VIa(N)

  Filling-in for record : (  7)   Germany                1 VIa(N)
Mean Weighted by Sampled Catches of:
  >>  ( 14)  Netherlands            1 VIa(N)-SS
  >>  ( 15)  Netherlands            1 VIa(N)

  Filling-in for record : (  8)   Germany                2 VIa(N)
Mean Weighted by Sampled Catches of:
  >>  ( 14)  Netherlands            1 VIa(N)-SS
  >>  ( 15)  Netherlands            1 VIa(N)
  >>  (  9)  Germany                3 VIa(N)
  >>  ( 16)  Netherlands            3 VIa(N)
  >>  ( 21)  Scotland               3 VIa(N)


  Filling-in for record : ( 10)   Germany                4 VIa(N)
Using Only
  >>  ( 22)  Scotland               4 VIa(N)

  Filling-in for record : ( 12)   N. Ireland            3 VIa(N)
Mean Weighted by Sampled Catches of:
  >>  (  9)  Germany                3 VIa(N)
  >>  ( 16)  Netherlands            3 VIa(N)
  >>  ( 21)  Scotland               3 VIa(N)

  Filling-in for record : ( 13)   N. Ireland            4 VIa(N)
Using Only
  >>  ( 22)  Scotland               4 VIa(N)

  Filling-in for record : ( 18)   Norway                 3 VIa(N)
Mean Weighted by Sampled Catches of:
  >>  (  9)  Germany                3 VIa(N)
  >>  ( 16)  Netherlands            3 VIa(N)
  >>  ( 21)  Scotland               3 VIa(N)

  Filling-in for record : ( 19)   Scotland               1 VIa(N)
Mean Weighted by Sampled Catches of:
  >>  ( 14)  Netherlands            1 VIa(N)-SS
  >>  ( 15)  Netherlands            1 VIa(N)

  Filling-in for record : ( 20)   Scotland               2 VIa(N)
Mean Weighted by Sampled Catches of:
  >>  ( 14)  Netherlands            1 VIa(N)-SS
  >>  ( 15)  Netherlands            1 VIa(N)
  >>  (  9)  Germany                3 VIa(N)
  >>  ( 16)  Netherlands            3 VIa(N)
  >>  ( 21)  Scotland               3 VIa(N)

  Filling-in for record : ( 23)   Scotland               1 Vb
Mean Weighted by Sampled Catches of:
```

Table 5.1.3. Continued

```
>>  ( 14)  Netherlands            1 VIa(N)-SS
>>  ( 15)  Netherlands            1 VIa(N)
```

Catch Numbers at Age by Area

For Periods 1 to 4

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.00	0.00	0.00	0.00
1	9092.30	0.00	0.00	9092.30
2	74166.50	0.00	0.00	74166.50
3	34552.86	0.00	17.85	34570.71
4	31878.01	0.00	27.15	31905.17
5	22851.45	9.00	11.20	22871.66
6	14323.27	27.00	22.18	14372.46
7	8596.33	36.00	8.81	8641.14
8	2785.37	27.00	12.97	2825.33
9	3311.88	0.00	14.73	3326.61

Mean Weight at Age by Area (Kg)

For Periods 1 to 4

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.0000	0.0000	0.0000	0.0000
1	0.0969	0.0000	0.0000	0.0969
2	0.1380	0.0000	0.0000	0.1380
3	0.1589	0.0000	0.1080	0.1588
4	0.1824	0.0000	0.1180	0.1824
5	0.1987	0.2040	0.1367	0.1986
6	0.2182	0.2670	0.1435	0.2182
7	0.2265	0.2730	0.1412	0.2266
8	0.2113	0.2800	0.1473	0.2117
9	0.1997	0.0000	0.1360	0.1994

Mean Length at Age by Area (cm)

For Periods 1 to 4

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.0000	0.0000	0.0000	0.0000
1	222.7054	0.0000	0.0000	222.7054
2	248.2123	0.0000	0.0000	248.2123
3	265.5509	0.0000	254.0000	265.5449
4	280.9479	0.0000	266.0000	280.9352
5	288.7585	287.5000	276.9006	288.7522
6	298.6538	309.2000	284.1301	298.6512
7	301.7146	316.3000	285.6078	301.7589
8	303.0356	317.5000	286.6235	303.0985
9	299.7152	0.0000	286.0000	299.6545

Catch Numbers at Age by Area

For Period 1

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	1503.88	0.00	17.85	1521.73
4	2288.19	0.00	27.15	2315.34
5	935.21	9.00	11.20	955.42
6	1842.38	27.00	22.18	1891.57
7	706.42	36.00	8.81	751.23
8	1065.70	27.00	12.97	1105.66
9	1241.18	0.00	14.73	1255.91

Table 5.1.3. Continued

Mean Weight at Age by Area (Kg)

For Period 1

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000
3	0.1080	0.0000	0.1080	0.1080
4	0.1180	0.0000	0.1180	0.1180
5	0.1353	0.2040	0.1367	0.1359
6	0.1409	0.2670	0.1435	0.1427
7	0.1387	0.2730	0.1412	0.1451
8	0.1445	0.2800	0.1473	0.1479
9	0.1360	0.0000	0.1360	0.1360

Mean Length at Age by Area (cm)

For Period 1

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000
3	254.0000	0.0000	254.0000	254.0000
4	266.0000	0.0000	266.0000	266.0000
5	276.6705	287.5000	276.9006	276.7751
6	283.5937	309.2000	284.1301	283.9655
7	285.0209	316.3000	285.6078	286.5267
8	285.9834	317.5000	286.6235	286.7606
9	286.0000	0.0000	286.0000	286.0000

Catch Numbers at Age by Area

For Period 2

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.00	0.00	0.00	0.00
1	314.81	0.00	0.00	314.81
2	3405.55	0.00	0.00	3405.55
3	1408.93	0.00	0.00	1408.93
4	1577.73	0.00	0.00	1577.73
5	1199.51	0.00	0.00	1199.51
6	751.75	0.00	0.00	751.75
7	449.25	0.00	0.00	449.25
8	105.00	0.00	0.00	105.00
9	118.43	0.00	0.00	118.43

Mean Weight at Age by Area (Kg)

For Period 2

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.0000	0.0000	0.0000	0.0000
1	0.1088	0.0000	0.0000	0.1088
2	0.1365	0.0000	0.0000	0.1365
3	0.1681	0.0000	0.0000	0.1681
4	0.1936	0.0000	0.0000	0.1936
5	0.2105	0.0000	0.0000	0.2105
6	0.2402	0.0000	0.0000	0.2402
7	0.2367	0.0000	0.0000	0.2367
8	0.2670	0.0000	0.0000	0.2670
9	0.2477	0.0000	0.0000	0.2477

Mean Length at Age by Area (cm)

Table 5.1.3. Continued

For Period 2

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.0000	0.0000	0.0000	0.0000
1	225.0000	0.0000	0.0000	225.0000
2	249.1471	0.0000	0.0000	249.1471
3	267.9818	0.0000	0.0000	267.9818
4	279.7321	0.0000	0.0000	279.7321
5	288.6140	0.0000	0.0000	288.6140
6	300.7927	0.0000	0.0000	300.7927
7	299.2081	0.0000	0.0000	299.2081
8	317.9617	0.0000	0.0000	317.9617
9	306.4676	0.0000	0.0000	306.4676

Catch Numbers at Age by Area

For Period 3

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.00	0.00	0.00	0.00
1	4604.88	0.00	0.00	4604.88
2	49814.02	0.00	0.00	49814.02
3	20175.27	0.00	0.00	20175.27
4	22418.33	0.00	0.00	22418.33
5	17273.34	0.00	0.00	17273.34
6	10457.09	0.00	0.00	10457.09
7	6357.31	0.00	0.00	6357.31
8	1220.94	0.00	0.00	1220.94
9	1374.49	0.00	0.00	1374.49

Mean Weight at Age by Area (Kg)

For Period 3

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.0000	0.0000	0.0000	0.0000
1	0.1088	0.0000	0.0000	0.1088
2	0.1437	0.0000	0.0000	0.1437
3	0.1688	0.0000	0.0000	0.1688
4	0.1921	0.0000	0.0000	0.1921
5	0.2055	0.0000	0.0000	0.2055
6	0.2328	0.0000	0.0000	0.2328
7	0.2394	0.0000	0.0000	0.2394
8	0.2690	0.0000	0.0000	0.2690
9	0.2466	0.0000	0.0000	0.2466

Mean Length at Age by Area (cm)

For Period 3

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.0000	0.0000	0.0000	0.0000
1	225.0000	0.0000	0.0000	225.0000
2	248.2377	0.0000	0.0000	248.2377
3	266.5552	0.0000	0.0000	266.5552
4	283.2946	0.0000	0.0000	283.2946
5	290.3716	0.0000	0.0000	290.3716
6	301.4762	0.0000	0.0000	301.4762
7	304.2093	0.0000	0.0000	304.2093
8	318.5822	0.0000	0.0000	318.5822
9	309.6087	0.0000	0.0000	309.6087

Catch Numbers at Age by Area

Table 5.1.3. Continued

For Period 4

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.00	0.00	0.00	0.00
1	4172.61	0.00	0.00	4172.61
2	20946.92	0.00	0.00	20946.92
3	11464.78	0.00	0.00	11464.78
4	5593.77	0.00	0.00	5593.77
5	3443.39	0.00	0.00	3443.39
6	1272.05	0.00	0.00	1272.05
7	1083.34	0.00	0.00	1083.34
8	393.73	0.00	0.00	393.73
9	577.78	0.00	0.00	577.78

Mean Weight at Age by Area (Kg)

For Period 4

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.0000	0.0000	0.0000	0.0000
1	0.0829	0.0000	0.0000	0.0829
2	0.1246	0.0000	0.0000	0.1246
3	0.1468	0.0000	0.0000	0.1468
4	0.1668	0.0000	0.0000	0.1668
5	0.1774	0.0000	0.0000	0.1774
6	0.1976	0.0000	0.0000	0.1976
7	0.2037	0.0000	0.0000	0.2037
8	0.1981	0.0000	0.0000	0.1981
9	0.2153	0.0000	0.0000	0.2153

Mean Length at Age by Area (cm)

For Period 4

Ages	VIa(N)	VIa(N)-SS	Vb	Total
0	0.0000	0.0000	0.0000	0.0000
1	220.0000	0.0000	0.0000	220.0000
2	248.0000	0.0000	0.0000	248.0000
3	265.0000	0.0000	0.0000	265.0000
4	278.0000	0.0000	0.0000	278.0000
5	284.0000	0.0000	0.0000	284.0000
6	296.0000	0.0000	0.0000	296.0000
7	299.0000	0.0000	0.0000	299.0000
8	297.0000	0.0000	0.0000	297.0000
9	304.2581	0.0000	0.0000	304.2581

Table 5.1.4. Estimated catches at age of herring in Area VIa(N). Catches in number in 1997 are calculated including catches in the area 4 to 5 degrees W.

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	69053	34836	22525	247	2692	36740	13304	81923	2207	40794	33768
2	319604	47739	46284	142	279	77961	250010	77810	188778	68845	154963
3	101548	95834	20587	77	95	105600	72179	92743	49828	148399	86072
4	35502	22117	40692	19	51	61341	93544	29262	35001	17214	118860
5	25195	10083	6879	13	13	21473	58452	42535	14948	15211	18836
6	76289	12211	3833	8	9	12623	23580	27318	11366	6631	18000
7	10918	20992	2100	4	8	11583	11516	14709	9300	6907	2578
8	3914	2758	6278	1	1	1309	13814	8437	4427	3323	1427
9	12014	1486	1544	0	0	1326	4027	8484	1959	2189	1971

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	19463	1708	6216	14294	26396	5253	17719	1728	266	1952	2030
2	65954	119376	36763	40867	23013	24469	95288	36554	82176	37854	94974
3	45463	41735	109501	40779	25229	24922	18710	40193	30398	30899	59502
4	32025	28421	18923	74279	28212	23733	10978	6007	21272	9219	53871
5	50119	19761	18109	26520	37517	21817	13269	7433	5376	7508	39341
6	8429	28555	7589	13305	13533	33869	14801	8101	4205	2501	29780
7	7307	3252	15012	9878	7581	6351	19186	10515	8805	4700	17581
8	3508	2222	1622	21456	6892	4317	4711	12158	7971	8458	8871
9	5983	2360	3505	5522	4456	5511	3740	10206	9787	31108	16819

	1998
1	9092
2	74167
3	34571
4	31905
5	22872
6	14372
7	8641
8	2825
9	3327

Table 5.1.5. HERRING in Division VIa (North). Larvae abundance indices (Numbers in billions), larvae mortality rates (Z/K), fecundity estimate (10^5 eggs/g). LPE Biomass estimate in thousands of tonnes.

Year	LAI	10% Trim LAI	Z/K	LPE		
				Larvae	Fecundity	SSB
1973	2 442	46.49	0.74	318	(1.39)	229
1974	1 186	17.44	0.42	238	(1.39)	171
1975	878	22	0.46	157	1.46	108
1976	189	11.04	-	60	1.23	49
1977	787	25	-	223	1.49	150
1978	332	32.8	-	132	1.37	109
1979	1 071	26.94		118	1.49	79
1980	1 436	26.33	0.39	287	2.04	141
1981	2 154	35.61	0.34	448	2.12	211
1982	1 890	32.58	0.39	267	1.95	137
1983	668	24.55	-	112	1.88	60
1984	2 133	45.99	0.57	253	1.75	145
1985	2 710	50.03	0.37	418	(1.86)	225
1986	3 037	45.36	0.24	907	(1.86)	488
1987	4 119	45.47	0.53	423	(1.86)	227
1988	5 947	75.13	0.47	781	(1.86)	420
1989	4 320	82.68	0.40	752	(1.86)	404
1990	6 525	86.2	0.64	426	(1.86)	229
1991	4 430	63.06	0.60	632	(1.86)	340
1992	12 252	41.79	0.66	463	(1.86)	248
1993	2 941	65.01	0.56	538	(1.86)	289

Table 5.1.6 HERRING in Division VIa (North). Estimates of abundance from Scottish acoustic surveys. Thousands of fish at age, and spawning biomass (SSB, tonnes).

Age	1987	1991	1992	1993	1994	1995	1996	1997#	1998
1	249 100	338 312	74 310	2 760	494 150	441 240	41 220	792 320	1 221 700
2	578 400	294 484	503 430	750 270	542 080	1103 400	576 460	641 860	794 630
3	551 100	327 902	210 980	681 170	607 720	473 220	802 530	286 170	666 780
4	353 100	367 830	258 090	653 050	285 610	450 270	329 110	167 040	471 070
5	752 600	488 288	414 750	544 000	306 760	152 970	95 360	66 100	179 050
6	111 600	176 348	240 110	865 150	268 130	187 100	60 600	49 520	79 270
7	48 100	98 741	105 670	284 110	406 840	169 080	77 380	16 280	28 050
8	15 900	89 830	56 710	151 730	173 740	236 540	78 190	28 990	13 850
9+	6 500	58 043	63 440	156 180	131 880	201 500	114 810	24 440	36 770
SSB:	273 000*	452 000	351 460	866 190	533 740	452 120	370300	140 910	375 890

* - Biomass of 2+ ringers in November. # The 1997 survey is not on the same basis as the other years, it was conducted in June(all other surveys were carried out in July). It is not used for assessment purposes.

Table 5.1.7. HERRING in Division VIa (North). Mean weights at age (g).

Weight in the catch

	1982-1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	90	69	113	73	80	82	79	84	91	89	83	105	81	89	97
2	140	103	145	143	112	142	129	118	122	128	142	142	134	136	138
3	175	134	173	183	157	145	173	160	172	158	167	180	178	177	159
4	205	161	196	211	177	191	182	203	194	197	190	191	210	205	182
5	231	182	215	220	203	190	209	211	216	206	195	198	230	222	199
6	253	199	230	238	194	213	224	229	224	228	201	213	233	223	218
7	270	213	242	241	240	216	228	236	236	223	244	207	262	219	227
8	284	223	251	253	213	204	237	261	251	262	234	227	247	238	212
9+	295	231	258	256	228	243	247	271	258	263	266	277	291	263	199

Weight in the stock from Acoustic surveys

(Age, Rings)	Historical	1992	1993	1994	1995	1996	1997	1998
1	90	68	75	52	45	45	57	65
2	164	152	162	150	144	140	150	138
3	208	186	196	192	191	180	189	177
4	233	206	206	220	202	209	209	193
5	246	232	226	221	225	219	225	214
6	252	252	234	233	226	222	233	226
7	258	271	254	241	247	229	248	234
8	269	296	260	270	260	242	266	225
9+	292	305	276	296	293	263	287	249

Table 5.1.8 HERRING in Division VIa (North). Maturity ogive used in estimates of spawning stock biomass taken from acoustic surveys. Values measured in 1997 were measured in June whilst other values are measured in July.

Year \Age (W ring)	2	3	>3
Mean 92-96	0.57	0.96	1.00
1992	0.47	1.00	1.00
1993	0.93	0.96	1.00
1994	0.48	0.92	1.00
1995	0.19	0.98	1.00
1996	0.76	0.94	1.00
1997	0.41	0.88	1.00
1998	0.85	0.97	1.00

Table 5.1.9 Herring in VIa(N). Evaluation of uncertainty in stock assessment using Bayes MCMC and assuming uniform prior uncertainty about the proportion of catches reported in the area between 4 and 5 degrees W that are allocated to the stock in 1997. Mean and percentiles of the distributions of spawning stock size, recruitment and fishing mortality.

Spawning Stock Size (Thousand t)

Year / Percentile	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5	92	114	129	118	102	87	87	83	77	105	70	50
25	111	141	167	164	144	129	123	115	104	144	95	76
Median	**143**	**183**	**221**	**228**	**201**	**180**	**170**	**158**	**138**	**185**	**124**	**104**
75	217	274	346	363	314	280	250	233	192	257	169	145
95	467	572	719	745	619	546	396	368	302	412	241	215
Mean	**194**	**250**	**311**	**322**	**280**	**251**	**197**	**184**	**157**	**214**	**137**	**115**

Mean Fishing Mortality over ages 3 to 6

Year / Percentile	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5	0.10	0.09	0.08	0.09	0.07	0.08	0.10	0.06	0.06	0.07	0.12	0.11
25	0.21	0.16	0.14	0.17	0.11	0.14	0.15	0.10	0.09	0.11	0.21	0.18
Median	**0.31**	**0.24**	**0.20**	**0.24**	**0.17**	**0.19**	**0.21**	**0.14**	**0.13**	**0.16**	**0.30**	**0.27**
75	0.39	0.30	0.25	0.32	0.23	0.26	0.29	0.20	0.18	0.22	0.42	0.39
95	0.47	0.37	0.31	0.42	0.32	0.36	0.51	0.31	0.28	0.36	0.64	0.65
Mean	**0.30**	**0.23**	**0.20**	**0.25**	**0.18**	**0.20**	**0.25**	**0.16**	**0.14**	**0.18**	**0.33**	**0.31**

Recruitment at age 1 (Millions)

Year / Percentile	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5	1800	854	618	419	342	457	400	712	469	367	252	1564
25	2008	1109	782	529	452	658	548	1038	696	563	464	3331
Median	**2352**	**1442**	**942**	**624**	**553**	**856**	**680**	**1342**	**936**	**801**	**702**	**5596**
75	3100	1936	1175	763	693	1092	870	1741	1271	1123	1039	8659
95	5807	3592	2098	1031	1086	1694	1237	2511	1896	1925	1925	13744
Mean	**3335**	**1733**	**1105**	**670**	**627**	**947**	**733**	**1442**	**1026**	**920**	**829**	**6315**

Yield (Thousand t)

Year / Percentile	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5	44	36	34	45	29	29	32	24	30	26	36	33
25	44	36	34	45	29	29	32	24	30	26	36	33
Median	**44**	**36**	**34**	**45**	**29**	**29**	**32**	**24**	**30**	**26**	**39**	**33**
75	44	36	34	45	29	29	32	24	30	26	43	33
95	44	36	34	45	29	29	32	24	30	26	52	33
Mean	**44**	**36**	**34**	**45**	**29**	**29**	**32**	**24**	**30**	**26**	**40**	**33**

Mean F in 1997-1998 relative to Mean F in 1992-1996

Percentile	
5	0.92
25	1.28
Median	**1.63**
75	2.11
95	2.93
Mean	**1.76**

Mean SSB in 1997-1998 relative to Mean SSB in 1992-1996

Percentile	
5	0.33
25	0.53
Median	**0.68**
75	0.83
95	1.12
Mean	**0.70**

Table 5.1.10. Herring in VIa(N). Input data and estimated parameters from weighted least-squares ICA calculation, based on a catch of 40,324t in 1997, being the mean of the posterior distribution from the Bayes calculation. These comparative estimates are provided for evaluation of diagnostics.

Output Generated by ICA Version 1.4

Herring in VIa(N)

Catch in Number

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	69.05	34.84	22.52	0.25	2.69	36.74	13.30	81.92	2.21	40.79	33.77	19.46	1.71	6.22	14.29
2	319.60	47.74	46.28	0.14	0.28	77.96	250.01	77.81	188.78	68.84	154.96	65.95	119.38	36.76	40.87
3	101.55	95.83	20.59	0.08	0.10	105.60	72.18	92.74	49.83	148.40	86.07	45.46	41.73	109.50	40.78
4	35.50	22.12	40.69	0.02	0.05	61.34	93.54	29.26	35.00	17.21	118.86	32.02	28.42	18.92	74.28
5	25.20	10.08	6.88	0.01	0.01	21.47	58.45	42.53	14.95	15.21	18.84	50.12	19.76	18.11	26.52
6	76.29	12.21	3.83	0.01	0.01	12.62	23.58	27.32	11.37	6.63	18.00	8.43	28.55	7.59	13.30
7	10.92	20.99	2.10	0.00	0.01	11.58	11.52	14.71	9.30	6.91	2.58	7.31	3.25	15.01	9.88
8	3.91	2.76	6.28	0.00	0.00	1.31	13.81	8.44	4.43	3.32	1.43	3.51	2.22	1.62	21.46
9	12.01	1.49	1.54	0.00	0.00	1.33	4.03	8.48	1.96	2.19	1.97	5.98	2.36	3.50	5.52

x 10 ^ 6

Catch in Number

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	26.40	5.25	17.72	1.73	0.27	1.95	1.37	9.09
2	23.01	24.47	95.29	36.55	82.18	37.85	63.87	74.17
3	25.23	24.92	18.71	40.19	30.40	30.90	40.02	34.57
4	28.21	23.73	10.98	6.01	21.27	9.22	36.23	31.91
5	37.52	21.82	13.27	7.43	5.38	7.51	26.46	22.87
6	13.53	33.87	14.80	8.10	4.21	2.50	20.03	14.37
7	7.58	6.35	19.19	10.52	8.80	4.70	11.82	8.64
8	6.89	4.32	4.71	12.16	7.97	8.46	5.97	2.83
9	4.46	5.51	3.74	10.21	9.79	31.11	11.31	3.33

x 10 ^ 6

Predicted Catch in Number

AGE	1993	1994	1995	1996	1997	1998
1	3569.	2176.	975.	1383.	2045.	9219.
2	96002.	64810.	60202.	29783.	88337.	53328.
3	21766.	28739.	31762.	32922.	34587.	36955.
4	15024.	6331.	13475.	16581.	37405.	14427.
5	19584.	6059.	4033.	9529.	25715.	21986.
6	17689.	8157.	3963.	2925.	15251.	15728.
7	23254.	11328.	8180.	4405.	7049.	14180.
8	5267.	10027.	7740.	6207.	7273.	4397.

x 10 ^ 3

Weights at age in the catches (Kg)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.08000	0.08000	0.08000	0.06900	0.11300	0.07300	0.08000	0.08200	0.07900
2	0.12100	0.12100	0.12100	0.12100	0.12100	0.12100	0.14000	0.14000	0.14000	0.10300	0.14500	0.14300	0.11200	0.14200	0.12900
3	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.17500	0.17500	0.17500	0.13400	0.17300	0.18300	0.15700	0.14500	0.17300
4	0.17500	0.17500	0.17500	0.17500	0.17500	0.17500	0.20500	0.20500	0.20500	0.16100	0.19600	0.21100	0.17700	0.19100	0.18200
5	0.18600	0.18600	0.18600	0.18600	0.18600	0.18600	0.23100	0.23100	0.23100	0.18200	0.21500	0.22000	0.20300	0.19000	0.20900
6	0.20600	0.20600	0.20600	0.20600	0.20600	0.20600	0.25300	0.25300	0.25300	0.19900	0.23000	0.23800	0.19400	0.21300	0.22400
7	0.21800	0.21800	0.21800	0.21800	0.21800	0.21800	0.27000	0.27000	0.27000	0.21300	0.24200	0.24100	0.24000	0.21600	0.22800
8	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.28400	0.28400	0.28400	0.22300	0.25100	0.25300	0.21300	0.20400	0.23700
9	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.29500	0.29500	0.29500	0.23100	0.25800	0.25600	0.22800	0.24300	0.24700

Weights at age in the catches (Kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	0.08400	0.09100	0.08900	0.08300	0.10600	0.08100	0.08900	0.09690
2	0.11800	0.11900	0.12800	0.14200	0.14200	0.13400	0.13600	0.13800
3	0.16000	0.18300	0.15800	0.16700	0.18100	0.17800	0.17700	0.15880
4	0.20300	0.19600	0.19700	0.19000	0.19100	0.21000	0.20500	0.12400
5	0.21100	0.22700	0.20600	0.19500	0.19800	0.23000	0.22200	0.19860
6	0.22900	0.21900	0.22800	0.20100	0.21400	0.23300	0.22300	0.21820
7	0.23600	0.24400	0.22300	0.24400	0.20800	0.26200	0.21900	0.22660
8	0.26100	0.25600	0.26200	0.23400	0.22700	0.24700	0.23800	0.21170
9	0.27100	0.25600	0.26300	0.26600	0.27700	0.29100	0.26300	0.19940

Table 5.1.10 (Contd.)

Weights at age in the stock (Kg)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000
2	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400
3	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800
4	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300
5	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600
6	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900
9	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200

Weights at age in the stock (Kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	0.09000	0.09000	0.07500	0.05200	0.04200	0.04500	0.05700	0.06553
2	0.16400	0.16400	0.16200	0.15000	0.14400	0.14000	0.15000	0.13783
3	0.20800	0.20800	0.19600	0.19200	0.19100	0.18000	0.18900	0.17625
4	0.23300	0.23300	0.20600	0.22000	0.20200	0.20900	0.20900	0.19394
5	0.24600	0.24600	0.22600	0.22100	0.22500	0.21900	0.22500	0.21420
6	0.25200	0.25200	0.23400	0.23300	0.22700	0.22200	0.23300	0.22618
7	0.25800	0.25800	0.25400	0.24100	0.24700	0.22900	0.24800	0.23449
8	0.26900	0.26900	0.26000	0.27000	0.26000	0.24200	0.26600	0.22504
9	0.29200	0.29200	0.27600	0.29600	0.29300	0.26300	0.28700	0.24907

Natural Mortality (per year)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Natural Mortality (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Proportion of fish spawning

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700
3	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5.1.10. (Contd.)

Proportion of fish spawning

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.5700	0.4700	0.9300	0.4800	0.1900	0.7600	0.5700	0.8500
3	0.9600	1.0000	0.9600	0.9200	0.9800	0.9400	0.9600	0.9700
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

INDICES OF SPAWNING BIOMASS

LPE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	189.0	787.0	332.0	1071.0	1436.0	2154.0	1890.0	668.0	2133.0	2710.0	3037.0	4119.0	5947.0	4320.0	6525.0

LPE

	1991	1992	1993
1	4430.0	*******	2941.0

AGE-STRUCTURED INDICES

West Scotland Summer Acoustic Survey

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	249.1	*******	*******	*******	338.3	74.3	2.8	494.2	460.6	41.2	*******	1221.7
2	578.4	*******	*******	*******	294.5	503.4	750.3	542.1	1085.1	576.5	*******	794.6
3	551.1	*******	*******	*******	327.9	211.0	681.2	607.7	472.7	802.5	*******	666.8
4	353.1	*******	*******	*******	367.8	258.1	653.0	285.6	450.2	329.1	*******	471.1
5	752.6	*******	*******	*******	488.3	414.8	544.0	306.8	153.0	95.4	*******	179.1
6	111.6	*******	*******	*******	176.3	240.1	865.2	268.1	187.1	60.6	*******	79.3
7	48.1	*******	*******	*******	98.7	105.7	284.1	406.8	169.2	77.4	*******	28.1
8	15.9	*******	*******	*******	89.8	56.7	151.7	173.7	236.6	78.2	*******	13.8
9	6.5	*******	*******	*******	58.0	63.4	156.2	131.9	201.5	114.8	*******	36.8

x 10 ^ 3

Fishing Mortality (per year)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.1945	0.0918	0.0395	0.0003	0.0047	0.0352	0.0271	0.0424	0.0029	0.0520	0.0559	0.0131	0.0022	0.0100	0.0391
2	0.7622	0.3528	0.2932	0.0005	0.0007	0.3175	0.6508	0.3811	0.2205	0.1962	0.5108	0.2524	0.1746	0.0975	0.1398
3	1.2046	0.5887	0.2689	0.0007	0.0004	0.4277	0.5876	0.5808	0.4825	0.2873	0.4276	0.2925	0.2668	0.2551	0.1580
4	1.0668	0.9135	0.5078	0.0003	0.0006	0.3955	0.7991	0.4769	0.4274	0.2885	0.3720	0.2641	0.2847	0.1764	0.2610
5	0.8878	0.9137	0.7216	0.0002	0.0003	0.3052	0.7125	0.9523	0.4233	0.2963	0.5170	0.2360	0.2308	0.2639	0.3545
6	1.0767	1.4378	0.9865	0.0014	0.0002	0.3139	0.5661	0.7689	0.6372	0.2993	0.5977	0.4081	0.1836	0.1169	0.2813
7	1.1291	0.8900	0.9486	0.0020	0.0015	0.2941	0.4642	0.7427	0.5730	0.9092	0.1626	0.4578	0.2423	0.1246	0.1963
8	0.9729	0.8804	0.6449	0.0008	0.0005	0.3193	0.5969	0.6494	0.4578	0.3653	0.4153	0.3082	0.2176	0.1640	0.2349
9	0.9729	0.8804	0.6449	0.0008	0.0005	0.3193	0.5969	0.6494	0.4578	0.3653	0.4153	0.3082	0.2176	0.1640	0.2349

Table 5.1.10 (Contd.)

Fishing Mortality (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	0.0915	0.0079	0.0050	0.0030	0.0027	0.0026	0.0061	0.0056
2	0.1365	0.1950	0.3364	0.2000	0.1792	0.1770	0.4054	0.3746
3	0.1271	0.2277	0.2831	0.1683	0.1508	0.1490	0.3411	0.3152
4	0.1484	0.1606	0.1981	0.1178	0.1056	0.1043	0.2387	0.2206
5	0.1822	0.1470	0.1730	0.1029	0.0922	0.0910	0.2085	0.1927
6	0.2745	0.2224	0.1531	0.0910	0.0815	0.0806	0.1845	0.1705
7	0.2290	0.1791	0.2095	0.1245	0.1116	0.1102	0.2524	0.2333
8	0.1831	0.1768	0.1981	0.1178	0.1056	0.1043	0.2387	0.2206
9	0.1831	0.1768	0.1981	0.1178	0.1056	0.1043	0.2387	0.2206

Population Abundance (1 January)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	608.3	623.6	917.8	1221.1	898.9	1676.2	786.3	3114.1	1213.5	1267.8	977.7	2365.5	1244.8	992.2	588.2
2	680.7	184.2	209.3	324.6	449.1	329.1	595.3	281.6	1098.1	445.1	442.8	340.1	858.9	457.0	361.4
3	156.9	235.3	95.9	115.6	240.3	332.4	177.5	230.0	142.5	652.5	271.0	196.8	195.8	534.4	307.1
4	56.4	38.5	106.9	60.0	94.6	196.7	177.5	80.8	105.4	72.0	400.8	144.7	120.3	122.8	339.0
5	44.7	17.6	14.0	58.2	54.3	85.6	119.8	72.2	45.4	62.2	48.8	250.0	100.5	81.9	93.1
6	120.5	16.6	6.4	6.1	52.7	49.1	57.1	53.2	25.2	26.9	41.8	26.3	178.6	72.2	56.9
7	16.8	37.2	3.6	2.1	5.6	47.7	32.5	29.3	22.3	12.1	18.0	20.8	15.8	134.5	58.1
8	6.6	4.9	13.8	1.3	1.9	5.0	32.1	18.5	12.6	11.4	4.4	13.9	11.9	11.3	107.5
9	20.1	2.6	3.4	8.2	8.5	5.1	9.4	18.6	5.6	7.5	6.1	23.6	12.7	24.3	27.7

x 10 ^ 6

Population Abundance (1 January)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	473.8	1056.8	1124.9	1152.7	576.6	827.8	535.3	2610.1	1050.0
2	208.1	159.1	385.7	411.7	422.8	211.6	303.7	195.7	954.8
3	232.8	134.5	97.0	204.1	249.7	261.8	131.3	150.0	99.7
4	214.7	167.9	87.7	59.8	141.2	175.8	184.7	76.4	89.6
5	236.3	167.4	129.4	65.1	48.1	115.0	143.4	131.6	55.5
6	59.1	178.2	130.8	98.5	53.1	39.7	95.0	105.3	98.2
7	38.9	40.6	129.1	101.6	81.3	44.3	33.1	71.5	80.3
8	43.2	28.0	30.7	94.7	81.1	65.8	35.9	23.3	51.2
9	27.9	35.7	21.8	96.4	102.6	329.9	55.9	17.6	29.7

x 10 ^ 6

Table 5.1.10 (Contd.)

Weighting factors for the catches in number

AGE	1993	1994	1995	1996	1997	1998
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted SSB Index Values

	LPE														
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	711.5	357.8	314.4	738.7	2052.7	2320.7	1623.9	895.0	2072.5	3293.4	2852.6	2625.6	3971.6	5499.2	5512.4

	LPE		
	1991	1992	1993
1	4147.2	*******	3092.8

Predicted Age-Structured Index Values

West Scotland Summer Acoustic Survey Predicted

Table 5.1.10 (Contd.)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	317.16	*******	*******	*******	61.56	141.99	151.30	155.18	77.63	111.45	*******	351.00
2	742.68	*******	*******	*******	475.96	355.36	814.42	918.06	950.62	476.06	*******	406.96
3	525.68	*******	*******	*******	664.41	368.69	259.95	573.02	705.95	740.71	*******	397.08
4	430.21	*******	*******	*******	668.48	520.19	267.69	188.54	447.41	557.31	*******	231.22
5	579.67	*******	*******	*******	559.78	402.35	307.60	159.17	118.15	282.57	*******	310.56
6	58.69	*******	*******	*******	138.90	427.56	322.69	249.00	134.90	100.81	*******	258.00
7	36.32	*******	*******	*******	74.27	79.25	248.67	202.41	162.95	88.83	*******	136.40
8	23.08	*******	*******	*******	75.67	49.06	53.49	170.18	146.47	118.90	*******	40.17
9	31.24	*******	*******	*******	38.82	49.70	30.14	137.45	146.96	472.85	*******	24.11

x 10 ^ 3

Fitted Selection Pattern

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.1823	0.1005	0.0777	0.9618	8.3779	0.0890	0.0339	0.0888	0.0067	0.1803	0.1503	0.0496	0.0076	0.0564	0.1497
2	0.7145	0.3862	0.5774	1.5222	1.2696	0.8027	0.8144	0.7991	0.5159	0.6800	1.3731	0.9557	0.6132	0.5526	0.5354
3	1.1293	0.6445	0.5295	2.2085	0.7699	1.0814	0.7353	1.2179	1.1288	0.9959	1.1493	1.1079	0.9371	1.4456	0.6052
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8322	1.0002	1.4210	0.7051	0.4442	0.7718	0.8917	1.9968	0.9904	1.0270	1.3896	0.8939	0.8109	1.4957	1.3579
6	1.0094	1.5740	1.9427	4.1123	0.3169	0.7937	0.7085	1.6124	1.4906	1.0373	1.6065	1.5455	0.6448	0.6625	1.0777
7	1.0584	0.9742	1.8680	5.8819	2.6729	0.7435	0.5809	1.5575	1.3406	3.1514	0.4371	1.7338	0.8511	0.7061	0.7521
8	0.9120	0.9638	1.2699	2.5226	0.9556	0.8073	0.7470	1.3617	1.0709	1.2662	1.1162	1.1671	0.7642	0.9292	0.9000
9	0.9120	0.9638	1.2699	2.5226	0.9556	0.8073	0.7470	1.3617	1.0709	1.2662	1.1162	1.1671	0.7642	0.9292	0.9000

Fitted Selection Pattern

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	0.6168	0.0491	0.0254	0.0254	0.0254	0.0254	0.0254	0.0254
2	0.9195	1.2145	1.6980	1.6980	1.6980	1.6980	1.6980	1.6980
3	0.8560	1.4180	1.4287	1.4287	1.4287	1.4287	1.4287	1.4287
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.2279	0.9156	0.8732	0.8732	0.8732	0.8732	0.8732	0.8732
6	1.8497	1.3846	0.7726	0.7726	0.7726	0.7726	0.7726	0.7726
7	1.5428	1.1152	1.0572	1.0572	1.0572	1.0572	1.0572	1.0572
8	1.2334	1.1006	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.2334	1.1006	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

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Table 5.1.10 (Contd.)

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1976	608330	265510	74576	93642	1.2557	1.0590	100
1977	623590	164455	53084	41341	0.7788	0.9634	109
1978	917780	172462	49790	22176	0.4454	0.6212	99
1979	1221110	220316	75971	60	0.0008	0.0007	99
1980	898910	257654	125936	306	0.0024	0.0004	99
1981	1676160	368357	133816	51420	0.3843	0.3606	103
1982	786330	310278	112155	92361	0.8235	0.6663	96
1983	3114060	442218	83533	63523	0.7604	0.6947	97
1984	1213520	371780	126535	56012	0.4427	0.4926	105
1985	1267830	370035	159108	39142	0.2460	0.2929	99
1986	977730	340532	148193	70764	0.4775	0.4786	95
1987	2365500	427469	142238	44360	0.3119	0.3002	102
1988	1244830	402380	174544	35591	0.2039	0.2415	97
1989	992210	387165	205022	34026	0.1660	0.2031	98
1990	588210	344294	205265	44693	0.2177	0.2637	101
1991	473810	278045	178318	28529	0.1600	0.1831	93
1992	1056840	302810	157340	28992	0.1843	0.1894	99
1993	1124860	290564	154238	31778	0.2060	0.2018	100
1994	1152740	289962	161308	24430	0.1514	0.1200	100
1995	576600	255450	152400	29575	0.1941	0.1075	99
1996	827790	297580	211802	26105	0.1233	0.1062	95
1997	535250	227674	134933	40324	0.2988	0.2432	99
1998	2610090	317682	108928	33353	0.3062	0.2248	106

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1976 . . . 1998
Number of indices of SSB : 1
Number of age-structured indices : 1

Parameters to estimate : 36
Number of observations : 137

Conventional single selection vector model to be fitted.

Table 5.1.10 (Contd.)

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1993	0.1981	23	0.1251	0.3139	0.1567	0.2505	0.2037
2	1994	0.1178	24	0.0732	0.1895	0.0924	0.1501	0.1213
3	1995	0.1055	24	0.0649	0.1717	0.0823	0.1353	0.1089
4	1996	0.1043	25	0.0628	0.1730	0.0805	0.1350	0.1078
5	1997	0.2387	29	0.1339	0.4257	0.1777	0.3207	0.2494
6	1998	0.2206	36	0.1077	0.4520	0.1530	0.3181	0.2359
Separable Model: Selection (S) by age								
7	1	0.0254	27	0.0148	0.0435	0.0193	0.0334	0.0264
8	2	1.6980	23	1.0701	2.6942	1.3416	2.1489	1.7457
9	3	1.4287	22	0.9239	2.2092	1.1438	1.7845	1.4645
	4	1.0000		Fixed : Reference Age				
10	5	0.8732	20	0.5899	1.2925	0.7148	1.0666	0.8908
11	6	0.7726	19	0.5240	1.1392	0.6338	0.9419	0.7879
12	7	1.0572	19	0.7149	1.5635	0.8659	1.2908	1.0785
	8	1.0000		Fixed : Last true age				
Separable model: Populations in year 1998								
13	1	2610093	60	794550	8574140	1422715	4788440	3137732
14	2	195716	42	85076	450244	127945	299385	214220
15	3	150013	42	65412	344034	98223	229110	164086
16	4	76427	38	35727	163489	51850	112651	82400
17	5	131628	34	67272	257549	93458	185387	139577
18	6	105301	31	56251	197120	76472	144997	110829
19	7	71476	28	40611	125798	53567	95372	74512
20	8	23293	30	12810	42356	17169	31602	24403
Separable model: Populations at age								
21	1993	30740	40	13866	68148	20479	46144	33384
22	1994	94717	30	51665	173643	69523	129041	99356
23	1995	81125	27	46924	140254	61355	107266	84353
24	1996	65821	26	39156	110644	50498	85792	68173
25	1997	35910	26	21193	60845	27439	46996	37233
SSB Index catchabilities LPE								
Power model fitted. Slopes (Q) and exponents (K) at age								
26	1 Q	7.554	19	6.343	13.87	7.683	11.45	9.569
27	1 K	.9988E-07	19	.8492E-06	.1857E-05	.1029E-05	.1533E-05	.1388E-05

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Table 5.1.10 (Contd.)

Age-structured index catchabilities

West Scotland Summer Acoustic Survey

Linear model fitted. Slopes at age :

28	1	Q	.2011	128	.5859E-01	9.007	.2011	2.624	1.658
29	2	Q	2.723	42	1.809	9.610	2.723	6.385	4.566
30	3	Q	3.253	42	2.160	11.50	3.253	7.636	5.459
31	4	Q	3.439	42	2.288	12.08	3.439	8.037	5.753
32	5	Q	2.652	42	1.769	9.252	2.652	6.169	4.422
33	6	Q	2.730	42	1.821	9.512	2.730	6.345	4.549
34	7	Q	2.180	42	1.455	7.595	2.180	5.067	3.633
35	8	Q	1.960	42	1.302	6.918	1.960	4.596	3.287
36	9	Q	1.555	42	1.033	5.491	1.555	3.647	2.608

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1993	1994	1995	1996	1997	1998
1	1.602	-0.231	-1.299	0.344	-0.404	-0.014
2	-0.007	-0.573	0.311	0.240	-0.324	0.330
3	-0.151	0.335	-0.044	-0.063	0.146	-0.067
4	-0.314	-0.053	0.457	-0.587	-0.032	0.794
5	-0.389	0.204	0.287	-0.238	0.029	0.039
6	-0.178	-0.007	0.059	-0.157	0.272	-0.090
7	-0.192	-0.074	0.074	0.065	0.517	-0.495
8	-0.112	0.193	0.029	0.309	-0.198	-0.442

SPAWNING BIOMASS INDEX RESIDUALS

LPE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-1.326	0.788	0.055	0.371	-0.357	-0.075	0.152	-0.293	0.029	-0.195	0.063	0.450	0.404	-0.241	0.169

Table 5.1.10 (Contd.)

LPE

	1991	1992	1993
1	0.066	*******	-0.050

AGE-STRUCTURED INDEX RESIDUALS

West Scotland Summer Acoustic Survey

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	-0.242	*******	*******	*******	1.704	-0.648	-4.004	1.158	1.781	-0.995	*******	1.247
2	-0.250	*******	*******	*******	-0.480	0.348	-0.082	-0.527	0.132	0.191	*******	0.669
3	0.047	*******	*******	*******	-0.706	-0.558	0.963	0.059	-0.401	0.080	*******	0.518
4	-0.198	*******	*******	*******	-0.597	-0.701	0.892	0.415	0.006	-0.527	*******	0.712
5	0.261	*******	*******	*******	-0.137	0.030	0.570	0.656	0.259	-1.086	*******	-0.551
6	0.643	*******	*******	*******	0.239	-0.577	0.986	0.074	0.327	-0.509	*******	-1.180
7	0.281	*******	*******	*******	0.285	0.288	0.133	0.698	0.038	-0.138	*******	-1.582
8	-0.373	*******	*******	*******	0.172	0.145	1.043	0.021	0.479	-0.419	*******	-1.065
9	-1.570	*******	*******	*******	0.402	0.244	1.645	-0.041	0.316	-1.416	*******	0.422

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1993 to 1998

Variance	0.3549
Skewness test stat.	1.7314
Kurtosis test statistic	6.3909
Partial chi-square	0.9746
Significance in fit	0.0000
Degrees of freedom	23

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

Table 5.1.10 (Contd.)

DISTRIBUTION STATISTICS FOR LPE

Power catchability relationship assumed
Last age is a plus-group

Variance	0.2176
Skewness test stat.	-2.0195
Kurtosis test statistic	2.2994
Partial chi-square	0.4894
Significance in fit	0.0000
Number of observations	17
Degrees of freedom	15
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR West Scotland Summer Acoustic Survey

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9
Variance	0.0420	0.0191	0.0346	0.0419	0.0380	0.0562	0.0519	0.0447	0.1218
Skewness test stat.	-1.2321	0.1940	0.4499	0.3276	-0.8366	-0.3403	-1.9594	-0.0557	-0.3172
Kurtosis test statisti	0.1196	-0.6072	-0.4636	-0.8260	-0.2929	-0.5344	1.0826	-0.2345	-0.3612
Partial chi-square	0.0250	0.0101	0.0188	0.0230	0.0213	0.0321	0.0308	0.0288	0.0779
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	8	8	8	8	8	8	8	8	8
Degrees of freedom	7	7	7	7	7	7	7	7	7
Weight in the analysis	0.0111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111

Table 5.1.10 (Contd.)

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	63.6115	137	36	101	0.6298
Catches at age	8.1636	48	25	23	0.3549
SSB Indices					
LPE	3.2635	17	2	15	0.2176
Aged Indices					
West Scotland Summer Acoustic Survey	52.1844	72	9	63	0.8283

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	11.7478	137	36	101	0.1163
Catches at age	8.1636	48	25	23	0.3549
SSB Indices					
LPE	3.2635	17	2	15	0.2176
Aged Indices					
West Scotland Summer Acoustic Survey	0.3207	72	9	63	0.0051

Table 5.1.11. Herring in VIa(N). ICA run log for the maximum-likelihood ICA calculation

```
                          Integrated Catch at Age Analysis
                          --------------------------------
                                  Version 1.4 w
                                  K.R.Patterson
                           Fisheries Research Services
                                Marine Laboratory
                                    Aberdeen
                                  8 March 1998
 Enter the name of the index file -->a
c:\herrwg99\h6a\data\canumest.csv
c:\herrwg99\h6a\data\weca.dat
 Stock weights in 1999  used for the year 1998
c:\herrwg99\h6a\data\west.dat
 Natural mortality in 1999  used for the year 1998
c:\herrwg99\h6a\data\natmor.dat
 Maturity ogive in 1999  used for the year 1998
c:\herrwg99\h6a\data\matprop.dat
 Name of age-structured index file (Enter if none) : -->b
 Name of the SSB index file (Enter if none) -->c
 No of years for separable constraint ?--> 6
 Reference age for separable constraint ?--> 4
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.000000000000000
 First age for calculation of reference F ?--> 3
 Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->y
 Is the last age of West Scotland Summer Acoustic Survey a plus-group (Y/N)-->y
You must choose a catchability model for each index.
 Model for   LPE  is to be A/L/P ?-->p
 Model for West Scotland Summer Acoustic Survey  is to be A/L/P ?-->l
 Fit a stock-recruit relationship (Y/N) ?-->n
 Enter lowest feasible F-->    5.00000000000000003E-02
 Enter highest feasible F-->    1.000000000000000
Mapping the F-dimension of the SSQ surface
    F                  SSQ
+--------+-------------------
    0.05          10.0831860140
    0.10           9.2134277907
    0.15           8.8757738253
    0.20           8.7966237163
    0.25           8.8449922212
    0.30           8.9587535191
    0.35           9.1077624600
    0.40           9.2775873998
    0.45           9.4623798827
    0.50           9.6622984841
    0.55           9.8852059882
    0.60          10.1594390804
    0.65          10.3527456466
    0.70          10.5197528720
    0.75          10.6943933108
    0.80          10.8490390064
    0.85          10.9569776236
    0.90          11.0600509241
    0.95          11.1585365217
    1.00          11.2527089695
Lowest SSQ is for F =     0.200
---------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1976  . . . 1998
Number of indices of SSB : 1
Number of age-structured indices : 1
Parameters to estimate : 35
Number of observations : 137
Conventional single selection vector model to be fitted.
---------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for   LPE-->    1.000000000000000
 Enter weight for West Scotland Summer Acoustic Survey  at age 1-->    0.100000000000000
 Enter weight for West Scotland Summer Acoustic Survey  at age 2-->    1.000000000000000
 Enter weight for West Scotland Summer Acoustic Survey  at age 3-->    1.000000000000000
 Enter weight for West Scotland Summer Acoustic Survey  at age 4-->    1.000000000000000
 Enter weight for West Scotland Summer Acoustic Survey  at age 5-->    1.000000000000000
 Enter weight for West Scotland Summer Acoustic Survey  at age 6-->    1.000000000000000
 Enter weight for West Scotland Summer Acoustic Survey  at age 7-->    1.000000000000000
 Enter weight for West Scotland Summer Acoustic Survey  at age 8-->    1.000000000000000
 Enter weight for West Scotland Summer Acoustic Survey  at age 9-->    1.000000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for West Scotland Summer Acoustic Survey-->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.
SSB index weights
  1.000
Aged index weights
West Scotland Summer Acoustic Survey
 Age   :       1     2     3     4     5     6     7     8     9
 Wts :     0.011 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111
F in 1998  at age 4  is 0.220641  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 132
 Estimate historical assessment uncertainty ?-->n
Succesful exit from ICA
```

Table 5.1.12. Herring in VIa(N). Example input file for stochastic projections, in this case for the option of F1999 = F1998, and for a catch constraint in 2000 = 68 000t

```
Projection input file HERR VIa(N)
Number of fleets          Number of Years
   1                          3
Catch Ratio for each fleet at age in 1997 : Including discarded fish
Age      All Fishery
       1   1.
       2   1.
       3   1.
       4   1.
       5   1.
       6   1.
       7   1.
       8   1.
       9   1.
Retention Ogive for each fleet by Age in All years
1         1.          1.          1.          1.          1.
2         1.          1.          1.          1.          1.
3         1.          1.          1.          1.          1.
4         1.          1.          1.          1.          1.
5         1.          1.          1.          1.          1.
6         1.          1.          1.          1.          1.
7         1.          1.          1.          1.          1.
8         1.          1.          1.          1.          1.
9         1.          1.          1.          1.          1.
Exploitation  Constraint by Year  (-ve values: F-constraints; +ve values, Catch constraints)
1999   -1.0       -1.0        -1.0       -1.0  -1.0
2000   68000       -1.0        -1.0       -1.0  -1.0
2001   68000       -1.0        -1.0       -1.0  -1.0
Mean weight at age in the catches of each fleet
       1 0.09118
       2 0.1384
       3 0.17236
       4 0.184
       5 0.20872
       6 0.21784
       7 0.23192
       8 0.23154
       9 0.25928
Mean weights at age in the discards by each fleet
       1 0.09118
       2 0.1384
       3 0.17236
       4 0.184
       5 0.20872
       6 0.21784
       7 0.23192
       8 0.23154
       9 0.25928
First year for management simulations
2010
Target F-Multipiers by fleet and by year
2010   -1.0       -1.0        -1.0       -1.0  -1.0
```

Table 5.1.13 Herring in VIa(N). Stochastic projections for F99=F98 and various catch constraints in 2000. Catch and Spawning Stock Biomass in thousands of tonnes.

1999

	Yield	Percentiles		
Basis	Expected	25%	50%	75%
F99=F98	50	36	45	57

SSB	Percentiles		
Expected	25%	50%	75%
131	80	116	166

F	Percentiles		
Expected	25%	50%	75%
0.31	0.18	0.27	0.39

2000

	Yield	Percentiles		
Basis	Expected	25%	50%	75%
F00=F99=F98	48	35	43	53
C00=28Kt	28	28	28	28
C00=35Kt	35	35	35	35
C00=42Kt	42	42	42	42
C00=68Kt	68	68	68	68

SSB	Percentiles		
Expected	25%	50%	75%
138	82	122	182
150	90	132	196
146	86	128	192
141	81	123	187
124	63	105	170

F	Percentiles		
Expected	25%	50%	75%
0.31	0.18	0.27	0.39
0.18	0.11	0.16	0.23
0.23	0.14	0.2	0.29
0.29	0.17	0.25	0.37
0.64	0.3	0.46	0.72

Table 5.1.14. Herring in VIa(N). Example ICP log file as used for the stochastic projections

```
                    Medium-Term Projections
                    -----------------------

                              ICP

                          K.R. Patterson
                    SOAEFD Marine Laboratory
                            Aberdeen


                  Written  December 1997 for ICA v1.4 w
                           Revision March 1999


 Enter Random-Number seed--> 120
 Enter the no. of years between spawning and  recruitment at age--> 1
 Change any of the populations (Y/N) ?-->n
 Enter the name of the projection file -->1.dat
Population parameters for the projections are set by taking a mean over a
number of the last years of the data set.
 Use mean natural mortality from 1998  back to--> 1994
 Use mean maturity ogive from 1998  back to--> 1994
 Use mean weight at age in the stock from 1998  back to--> 1994
 Enter the reference spawning stock size (e.g. MBAL, Bpa)-->
8.0000000000000000E+05
 Enter the maximum allowable F-multiplier-->   10.000000000000000
Choose type of stock recruit relation :
S -     Shepherd         R = a.SSB/(1+SSB/b)^c
B -  Beverton-Holt    R = a.SSB/(1+SSB/b)
R -  Ricker           R = a.SSB.exp(-b.SSB)
O -  Ockham           R = GM over observed SSB range
                          then linear to origin
N -     None             R = Historic Geometric Mean R
 Enter your choice (S/B/R/O/N) ?-->n
 Enter first year of data for stock-recruit model--> 1986
 Enter last year of data for stock-recruit model--> 1996
 Autocorrelated or Independent errors (I/A)-->i
 Use ICA or SRR (I/S) model value for recruitment in 1998-->s
 Use ICA or SRR (I/S) model value for recruitment in 1999-->s
 Use default percentiles (Y/N)  ?-->y
 Use ICA-derived resamples ?-->y
```

Table 5.2.1 Catches of HERRING from the Firth of Clyde. Spring and autumn-spawners combined. Catch in tonnes by country, 1955–1998.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
All Catches											
Total	4,050	4,848	5,915	4,926	10,530	15,680	10,848	3,989	7,073	14,509	15,096

Year	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
All Catches											
Total	9,807	7,929	9,433	10,594	7,763	4,088	4,226	4,715	4,061	3,664	4,139

Year	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Scotland						2,506	2,530	2,991	3,001	3,395	2,895
Other UK						-	273	247	22	-	-
Unallocated[1]						262	293	224	433	576	278
Discards						1,253	1,265	2,308[3]	1,344[3]	679[3]	439[4]
Agreed TAC								3,000	3,000	3,100	3,500
Total	4,847	3,862	1,951	2,081	2,135	4,021	4,361	5,770	4,800	4,650	3,612

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Scotland	1,568	2,135	2,184	713	929	852	608	392	598	371	779
Other UK	-	-	-	-	-	-	-	-	283	119	213
Unallocated[1]	110	208	75	18	-	-	-	-	-	-	-
Discards	245[4]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-	-	-
Agreed TAC	3,200	3,200	2,600	2,900	2,300	1,000	1,000	1,000	1,000	1,000	1,000
Total	1,923	2,343	2,259	731	929	852	608	392	881	490	992

[1]Calculated from estimates of weight per box and in some years estimated by-catch in the sprat fishery

[2]Reported to be at a low level, assumed to be zero.

[3]Based on sampling.

[4]Estimated assuming the same discarding rate as in 1986.

Table 5.2.2 Sampling levels of Clyde HERRING 1988-1998.

Year	Reported catch (tonnes)	No. of samples	No. of fish measured	No. of fish aged	Discards
1988	1,568	41	5,955	2,574	Based on local reports
1989	2,135	45	8,368	4,152	" "
1990	2,184	37	5,926	3,803	" "
1991	713	29	4,312	2,992	No information
1992	929	23	4,604	1,579	No information
1993	852	16	3,408	798	No information
1994	608	16	3,903	1,388	No information
1995	392	16	2,727	1,073	No information
1996	881	9	1,915	679	No information
1997	490	3	650	383	No information
1998	992	3	462	196	

Table 5.2.3 Clyde HERRING catch in numbers at age. Spring- and autumn-spawners combined. Thousands of fish.

	Age(Rings)									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	5008	2207	1351	9139	5308	12694	6194	1041	14123	507
2	7551	6503	8983	5258	8841	1876	10480	7524	1796	4859
3	10338	1976	3181	4548	2817	2483	913	6976	2259	807
4	8745	4355	1684	1811	2559	1024	1049	1062	2724	930
5	2306	3432	3007	918	1140	1072	526	1112	634	888
6	741	1090	1114	1525	494	451	638	574	606	341
7	760	501	656	659	700	175	261	409	330	289
8	753	352	282	307	253	356	138	251	298	156
9	227	225	177	132	87	130	178	146	174	119
10+	117	181	132	114	59	67	100	192	236	154

	Age(Rings)									
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	333	312	220	314	4156	1639	678	508	0	845
2	5633	2372	11311	10109	11829	2951	4574	1376	1062	1523
3	1592	2785	4079	5232	5774	4420	4431	3669	1724	9239
4	567	1622	2440	1747	3406	4592	4622	4379	2506	876
5	341	1158	1028	963	1509	2806	2679	3400	2014	452
6	204	433	663	555	587	2654	1847	1983	1319	252
7	125	486	145	415	489	917	644	1427	510	146
8	48	407	222	189	375	681	287	680	234	29
9	56	74	63	85	74	457	251	308	66	16
10+	68	18	53	38	80	240	79	175	16	5

	Age(Rings)								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	716	42	145	3	399	118	494	275	323
2	1004	615	411	418	964	1425	1962	2005	2731
3	839	472	493	261	964	186	1189	429	1779
4	7533	703	385	268	358	189	273	346	667
5	576	1908	1947	1305	534	149	544	18	344
6	359	169	333	327	319	130	183	52	77
7	329	92	91	78	76	66	208	0	55
8	119	113	69	111	57	35	127	5	35
9	49	22	32	38	16	15	52	61	55
10+	16	9	10	0	17	1	9	*	

* change to 9+ in 1997.

Table 5.2.4 HERRING in the Firth of Clyde. Mean weights at age in the catch and stock (g).

Age	Weight in the catch														
(rings)	1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	-	-	-	-	-	-	-	-	-	-	-	102	90	112	103
2	225	149	166	149	156	149	170	143	141	141	92	151	146	142	148
3	270	187	199	194	194	174	186	163	187	174	157	174	184	174	174
4	290	228	224	203	207	203	202	188	188	198	184	201	203	192	189
5	310	253	253	217	211	221	216	192	216	213	212	226	233	231	204
6	328	272	265	225	222	227	237	198	227	216	249	241	255	228	218
7	340	307	297	236	230	235	234	210	206	229	248	249	257	189	229
8	345	291	298	247	225	237	234	222	218	261	240	252	255	286	240
9	350	300	298	255	244	219	257	200	201	233	249	242	284	218	246
10+	350	300	321	258	230	254	272	203	221	254	294	270	239	*	

* change to 9+ in 1997

Table 5.2.5. Catch per unit effort on Clyde Herring 1974 to 1998, catch, Scottish Pair Effort. Pair days absense, raised pair effort (by additional non-pair catch) and estimated CPUE

Year	Catch	Pair Effort	Raised Pair Effort	CPUE
1974	4061	3376	3376	1.20
1975	3664	3209	3209	1.14
1976	4139	3016	3016	1.37
1977	4847	4186	4186	1.16
1978	3862	4379	4379	0.88
1979	1951	2933	2933	0.67
1980	2081	1982	1982	1.05
1981	2135	1529	1529	1.40
1982	4021	1755	1755	2.29
1983	4361	1644	1644	2.65
1984	5770	1401	1401	4.12
1985	4800	1688	1688	2.84
1986	4650	1375	1375	3.38
1987	3612	850	998	3.62
1988	1923	540	626	3.07
1989	2343	582	639	3.67
1990	2259	388	429	5.27
1991	731	169	254	2.88
1992	929	137	165	5.63
1993	852	194	224	3.80
1994	608	104	111	5.48
1995	392	79	89	4.40
1996	881	82	127	6.94
1997	490	12	36	13.60
1998	992	10	13.04	76.07

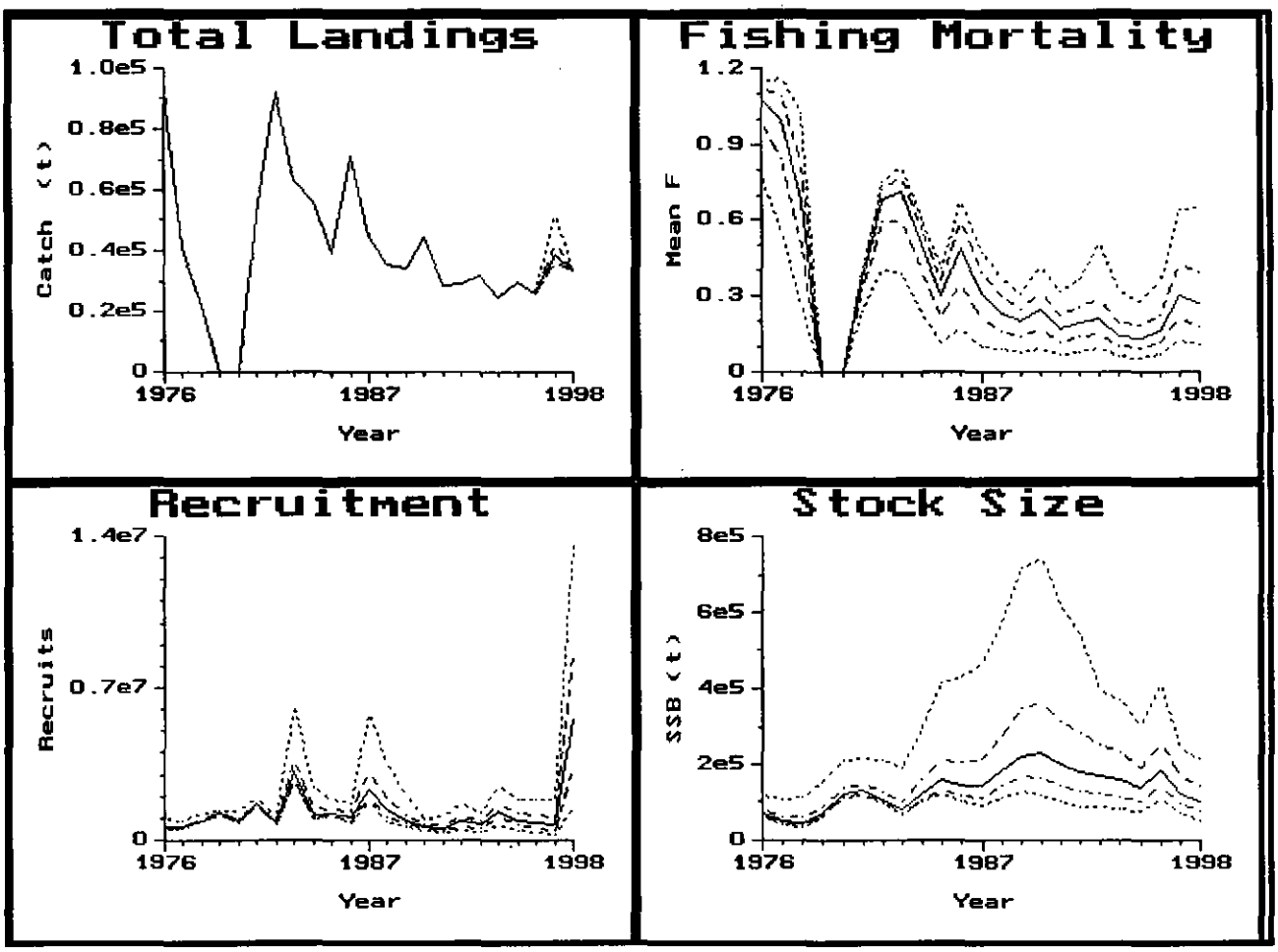


Figure 5.1.1 Herring in VIa(N). Results of Bayesian assessment. Summary estimates of landings, mean fishing mortality, recruitment age 1, stock size on 1 January and spawning stock biomass at spawning time. Dotted lines indicate the 5th and 95th percentiles, dashed lines indicate the 25th and 75th percentiles, unbroken lines indicate the medians.

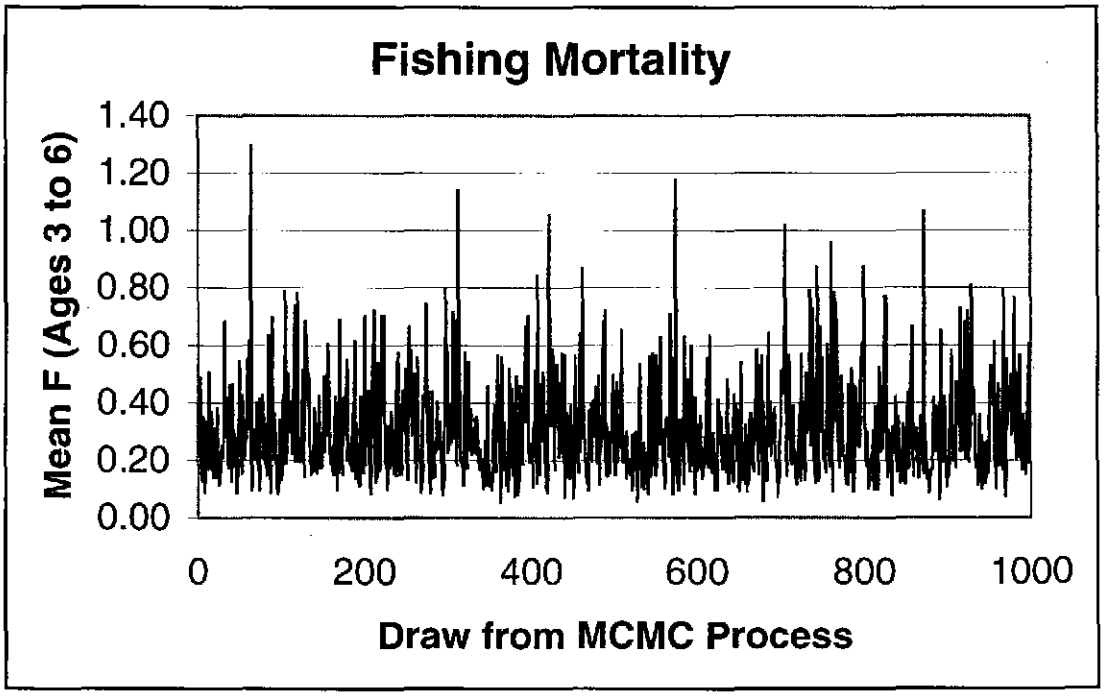


Figure 5.1.2. Values of fishing mortality in 1998 (ages 3 to 6) drawn from the MCMC process at intervals of 400 iterations.

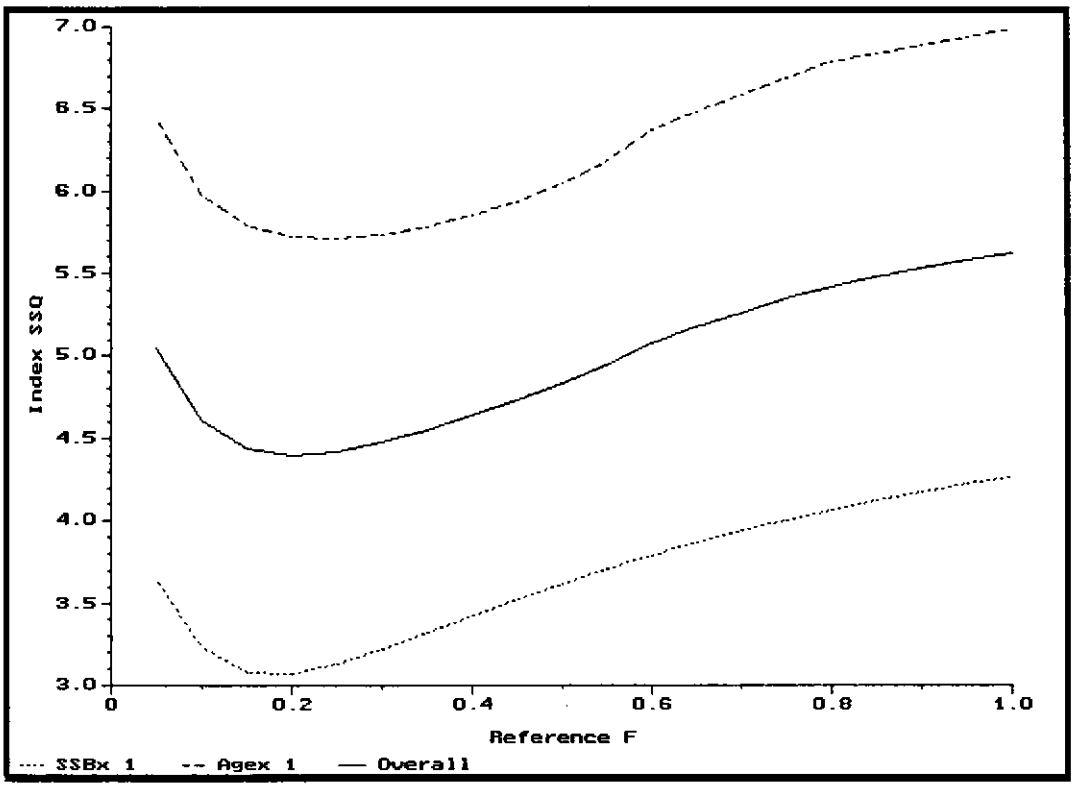


Figure 5.1.3 Herring in VIa(N). SSQ surface for the deterministic calculation. SSBx 1 - larval production estimates from 1973-1993; Agex1- age disaggregated acoustic estimates.

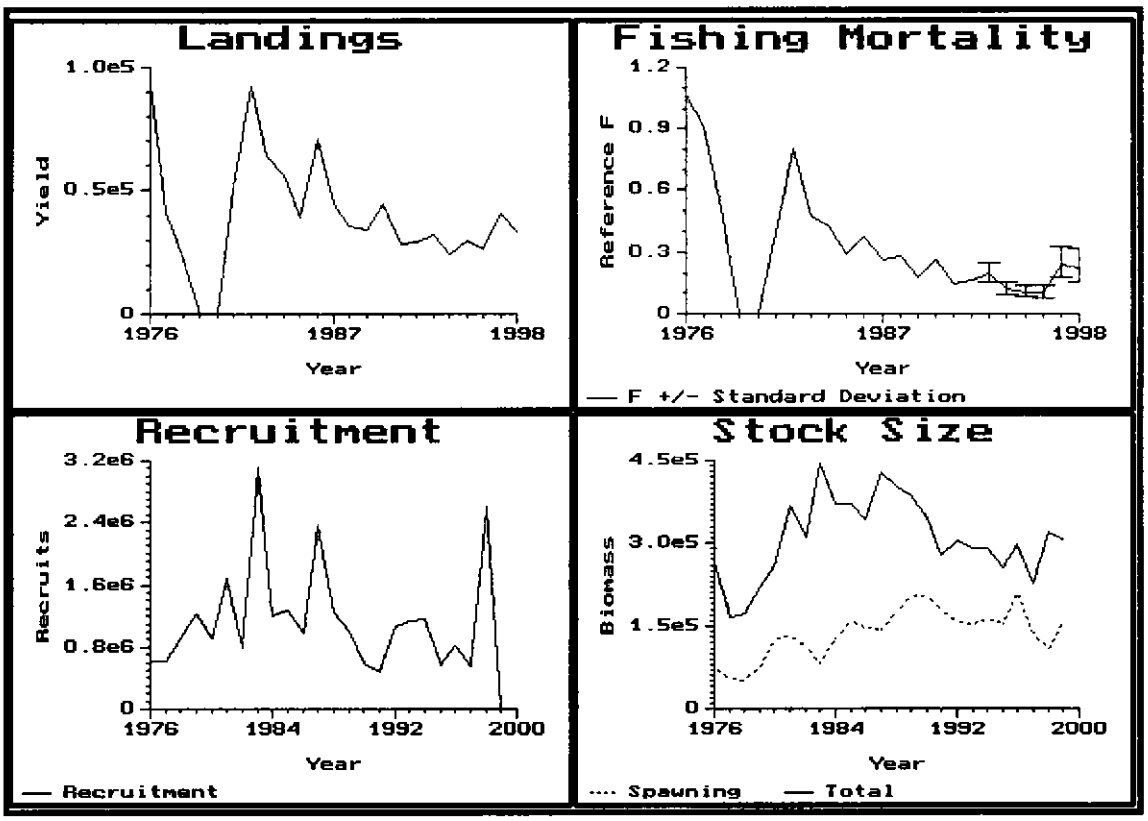


Figure 5.1.4 Herring in VIa(N). Illustration of stock trends from deterministic calculation. Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on 1 January and spawning stock at spawning time.

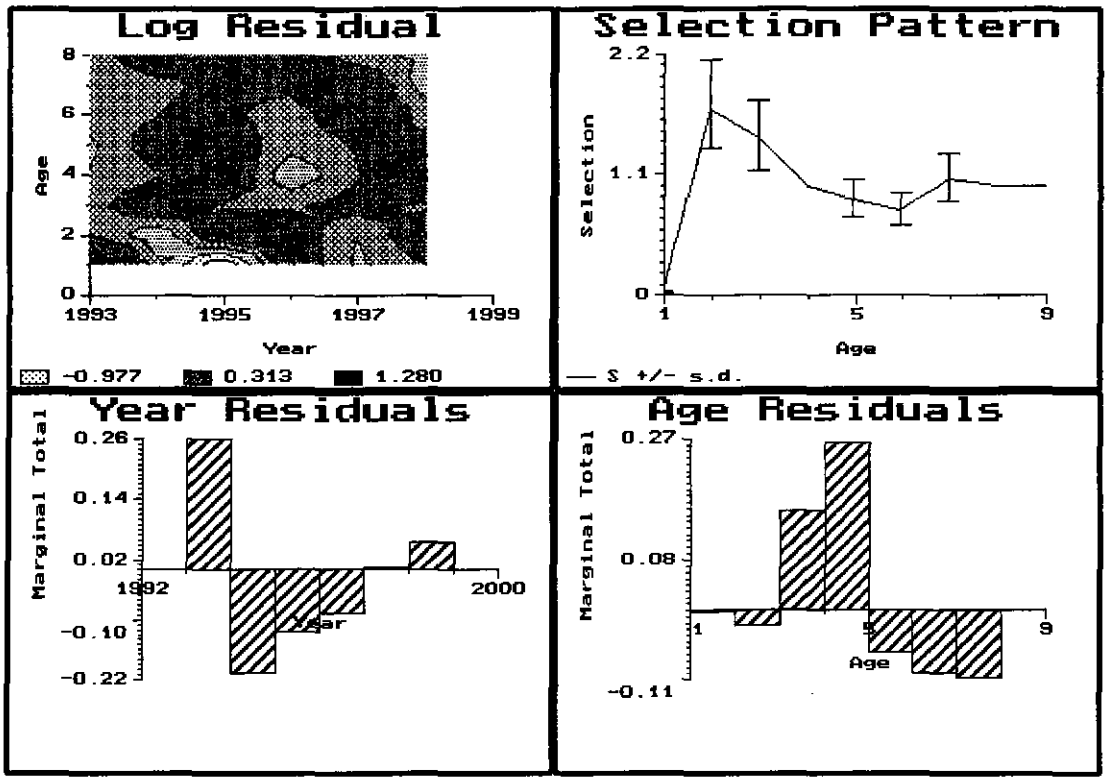


Figure 5.1.5 Illustration of selection patterns diagnostics, from deterministic calculation. Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

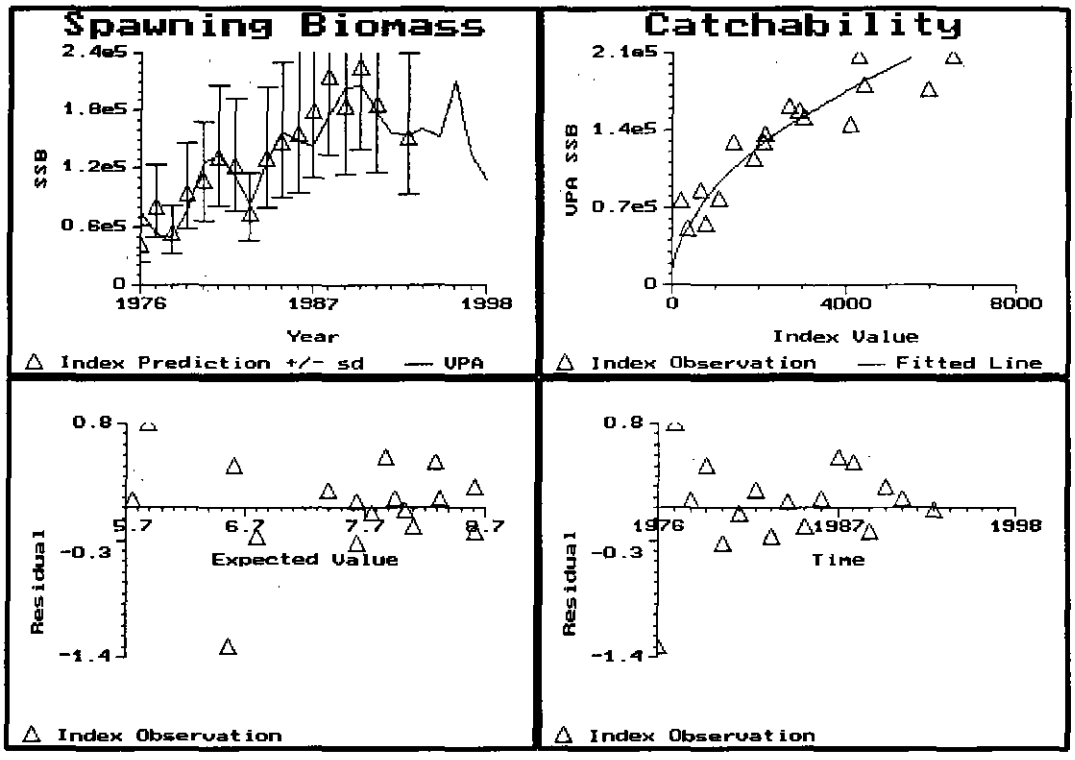


Figure 5.1.6 Herring in VIa(N). Illustration of residuals from deterministic calculation. Diagnostics of the fit of the larval index against the estimated spawning biomass. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larval index. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

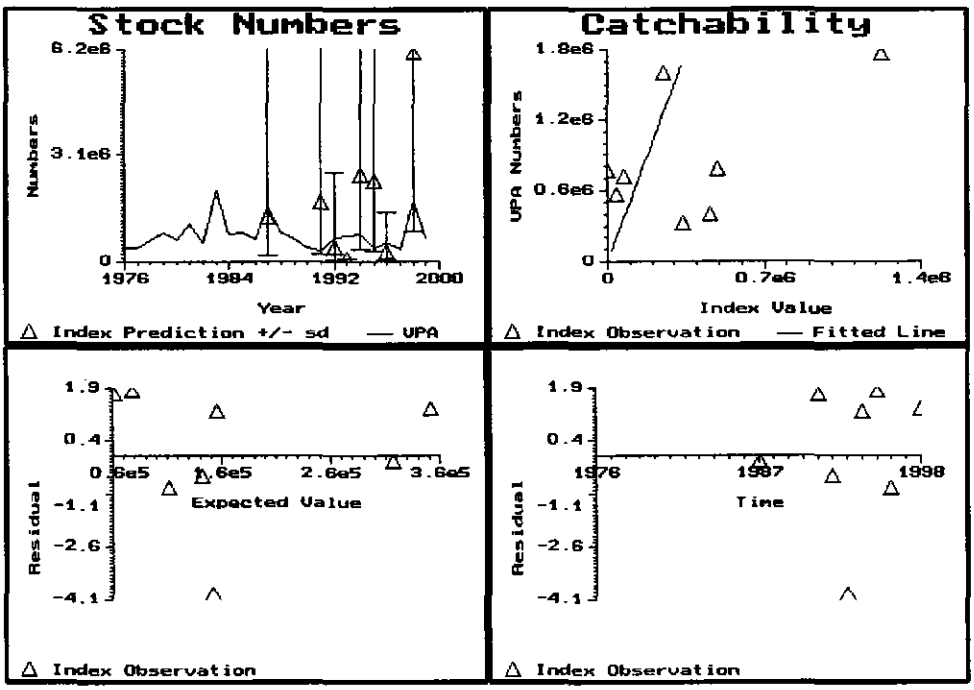


Figure 5.1.7 Herring in VIa(N). Illustration of residuals from deterministic calculation. Diagnostics of the fit of the age 1 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 1 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

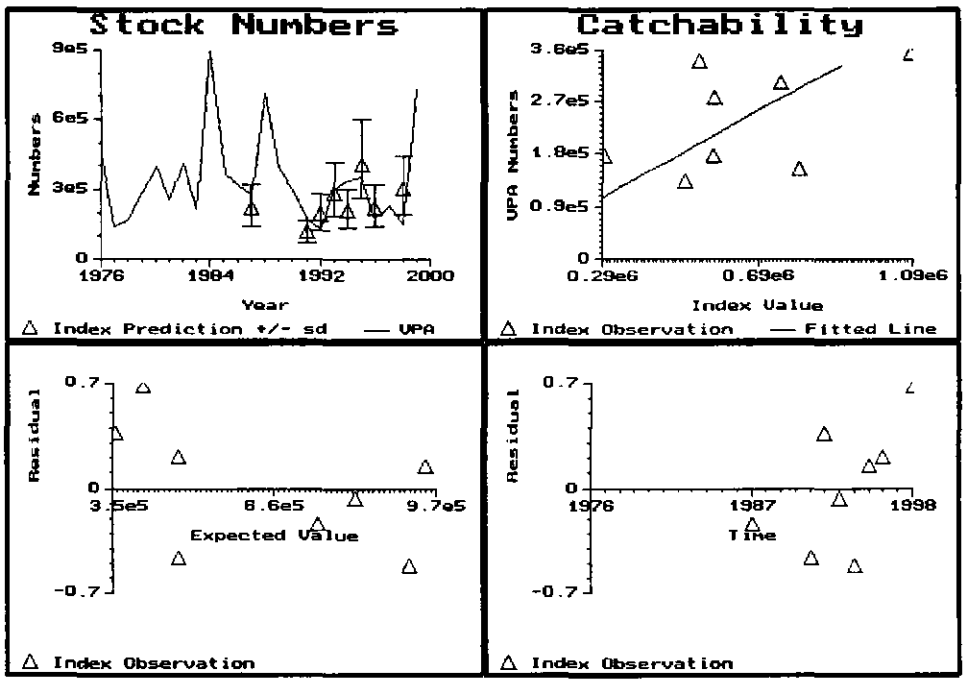


Figure 5.1.8 Herring in VIa(N). Illustration of residuals from deterministic calculation. Diagnostics of the fit of the age 2 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 2 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

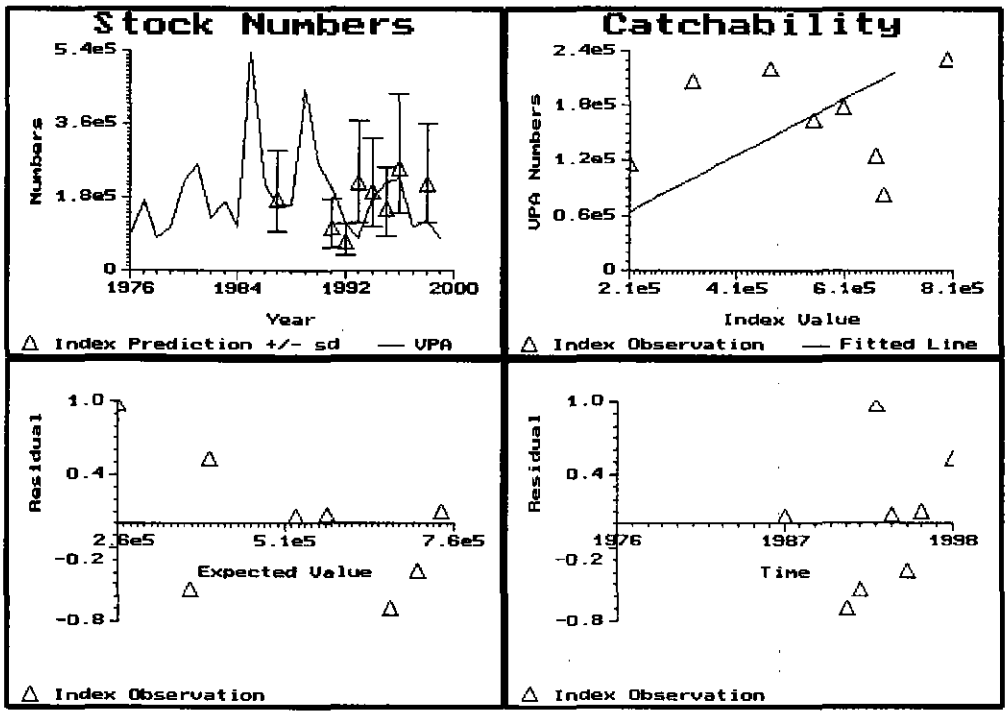


Figure 5.1.9 Herring in VIa(N). Illustration of residuals from deterministic calculation. Diagnostics of the fit of the age 3 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 3 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

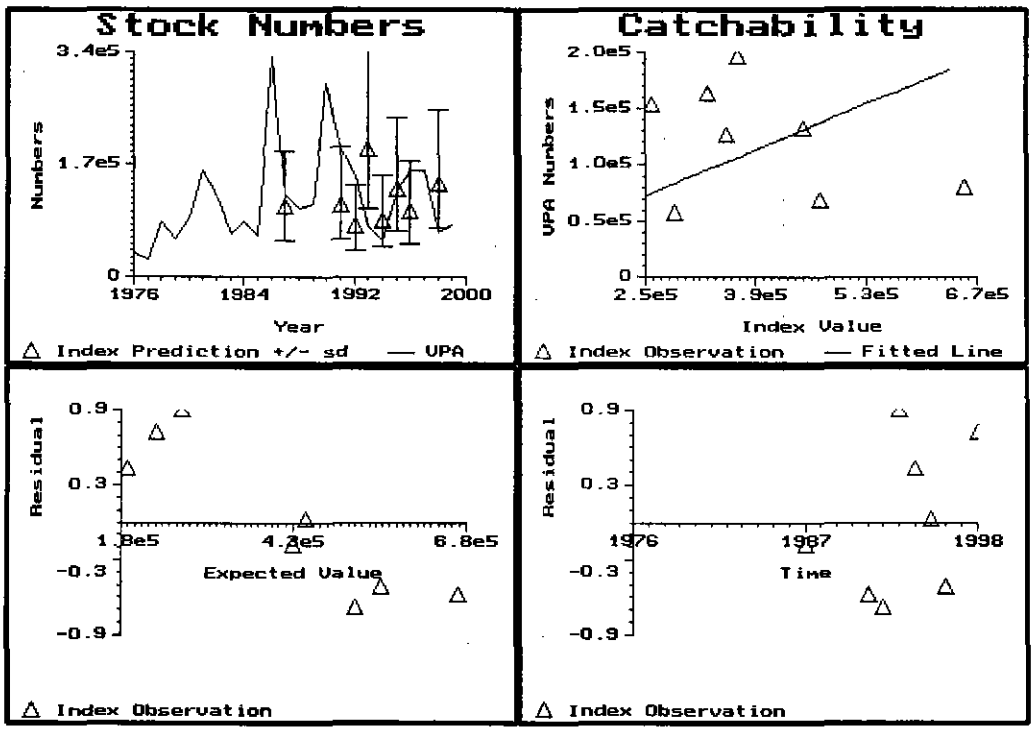


Figure 5.1.10 Herring in VIa(N). Illustration of residuals from deterministic calculation. Diagnostics of the fit of the age 4 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 4 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

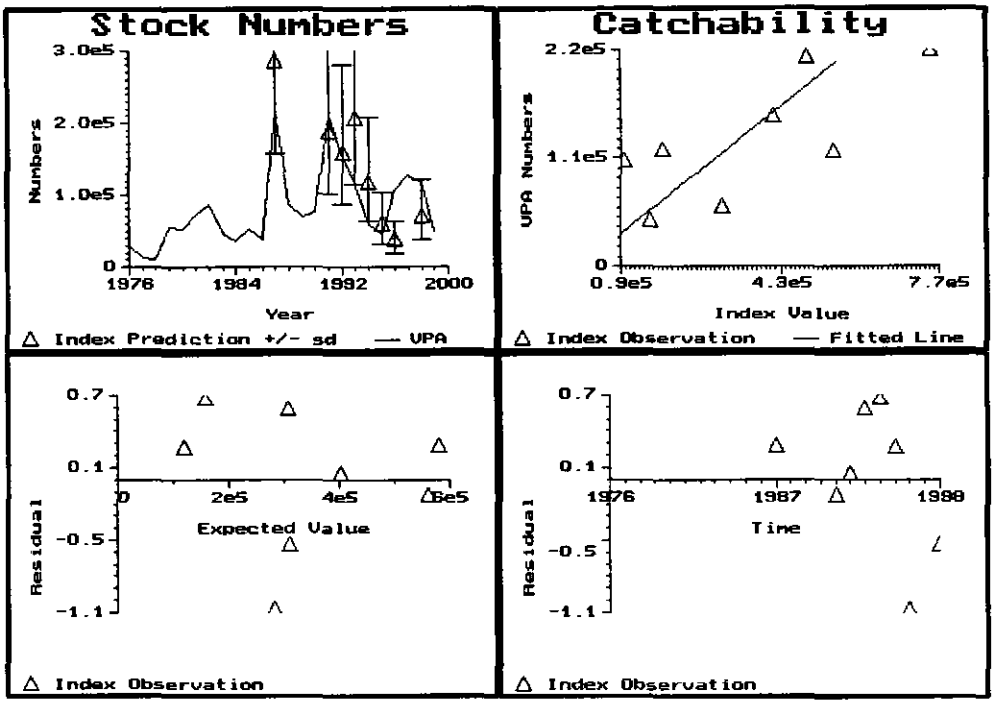


Figure 5.1.11 Herring in VIa(N). Illustration of residuals from deterministic calculation. Diagnostics of the fit of the age 5 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 5 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

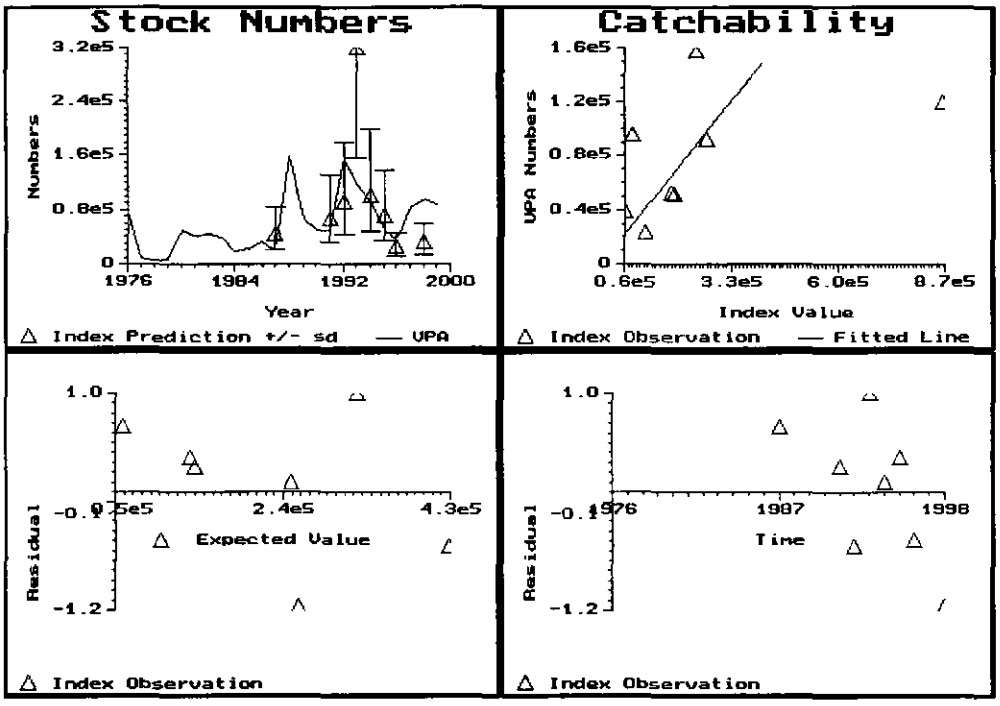


Figure 5.1.12 Herring in VIa(N). Illustration of residuals from deterministic calculation. Diagnostics of the fit of the age 6 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 6 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

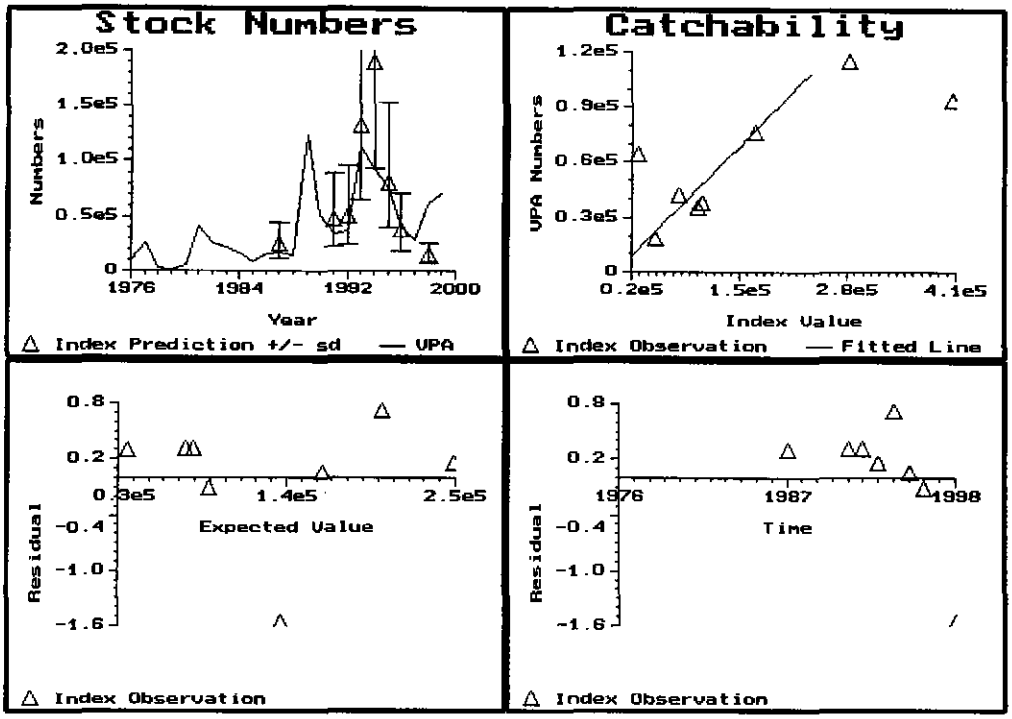


Figure 5.1.13 Herring in VIa(N). Illustration of residuals from deterministic calculation. Diagnostics of the fit of the age 7 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 7 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

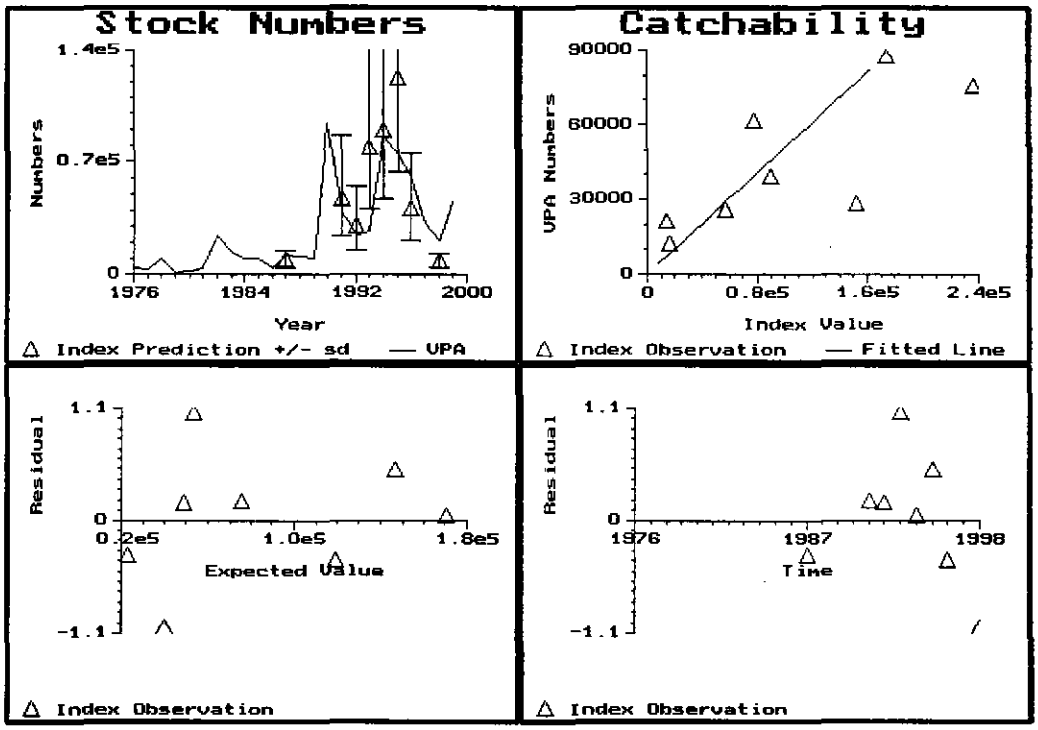


Figure 5.1.14 Herring in VIa(N). Illustration of residuals from deterministic calculation. Diagnostics of the fit of the age 8 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 8 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

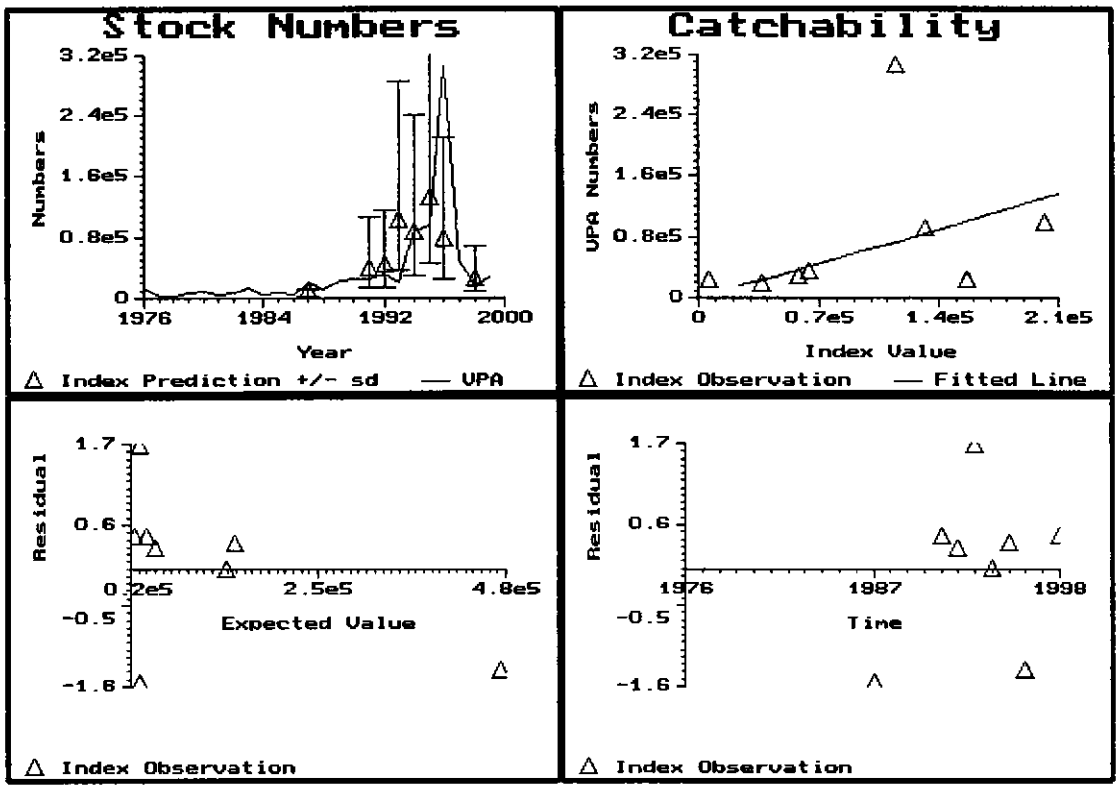


Figure 5.1.15 Herring in VIa(N). Illustration of residuals from deterministic calculation. Diagnostics of the fit of the age 9 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 9 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

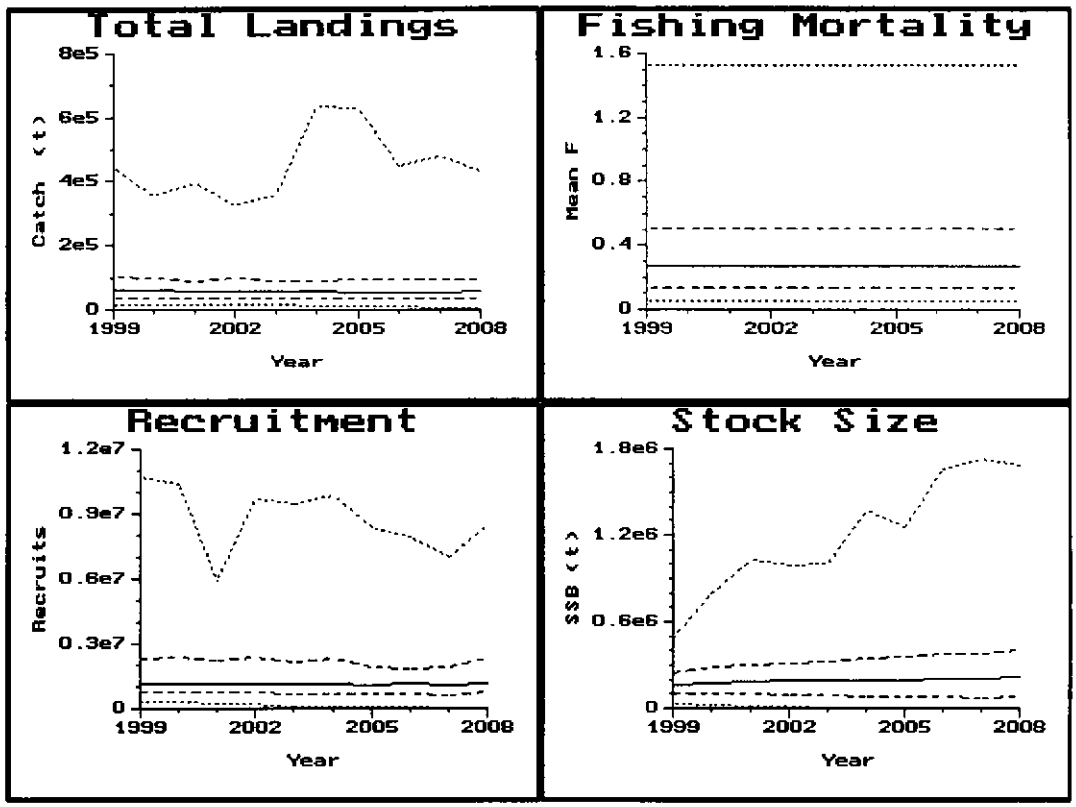


Figure 5.1.16. Herring in VIa(N). Medium-term projections based on the Bayesian assessment assuming a constant fishing mortality at the level estimated for 1998 (Expectation = 0.31).

6 HERRING IN DIVISIONS VIA (SOUTH) AND VIIB,C

6.1 The fishery

6.1.1 Advice and management applicable to 1998 and 1999

The TAC for this area for 1998 was 28,000 t. This was a precautionary TAC and was the same as that set each year since 1992. The total catch estimated by the Working Group to have been taken from the stock during 1998 was approximately 38,900 t. This catch was approximately 11,700 t higher than that recorded for 1996 and the highest catch recorded since 1990. There has been considerable misreporting of catches in this area. The total official catch is believed to have been much been much lower for a number of years than the actual catch taken from the stock.

In 1998 ACFM considered that it was problematic to judge the state of this stock because of the lack of fishery independent data. It was however considered to be harvested outside safe biological limits as defined by the proposed reference points. It was recommended that F in 1999 should be reduced by 30% to 0.41 in order to rebuild the SSB. This reduction in F corresponded to a catch of 19,000 t in 1999. The TAC set by the EU for 1999 was 21,000 t compared with 28,000 t for 1998.

6.1.2 Catch data

The main landings in 1998 from this fishery were again taken by Ireland who took over 95% of the total allocated catches. (Table 6.1.1)

The total amount of unallocated catches in 1998 was 11,000 t. This was the highest amount of unallocated catches from the area for a number of years and was mainly comprised of catches taken in Division VIaS but recorded as having been taken in Division VIaN.

The total international catches, from Sub-areas VI and VII per statistical rectangle, based on log book data, but not corrected for "misreporting" are shown in Figures 4.2.1 a-d.

The catches and landings taken by each country fishing in this area from 1987–1998 are shown in Table 6.1.1 and the total catches from 1970 are shown in Figure 6.1.1. There were no estimates of discards reported from 1997 and there are no indications that discarding is a major problem in this fishery even though substantial catches in recent years have been taken in a "roe" fishery. The catches for 1998 are preliminary. It has not been found necessary to make any revisions to the 1997 data.

6.1.3 The fishery in 1998

In 1998 increased catches were taken by the Irish fleet during Quarter 1. These catches were mainly taken from the spawning grounds off the north coast of Ireland in the northern part of Division VIaS and consisted of spawning fish. These winter/spring spawning fish have become increasingly abundant in this area in recent years and the Herring Working Group have commented on this on a number of occasions. As in recent years autumn spawning fish appeared to be scarce throughout the year particularly in the old traditional fishing grounds in Division VIIb. However large amounts of herring appeared during late October and November in the southern part of Division VIaS and considerable catches were made during this period. Over 50% of the total Irish catch taken during 1998 came from the first quarter. The increased Irish catches were the result of management decisions which allowed the fishery to remain open during the first and second quarters. The fishery was eventually closed in early December when the overall quota was reached.

Although there was a significant increase in the total catch taken from this fishery in 1998 the Irish fishery was, as in recent years, severely affected by poor markets. The number of Irish vessels that participated in the 1998 fishery was about the same as in recent years.

6.1.4 Catch in numbers at age

The catches at age for this fishery since 1970 are shown in Table 6.1.2. In recent years the catches in numbers at age have been derived mainly from Irish sampling data. The catches during 1998 were mainly dominated by 3 w.ring fish i.e., the 1994 year class which constituted over 32% of the total number. This year class also dominated the catches taken during 1997 when it recruited to the stock during the fourth quarter. Herring belonging to the 1995 year class constituted over 29% and again appeared to recruit during the fourth quarter.

6.1.5 Quality of the catch and biological data

The management of the Irish fishery in recent years is believed to have tightened considerably. Area misreporting of catches is still a problem between Divisions VIaN and VIaS and some doubts have also been expressed about some of the quantities and the species composition.

The numbers of samples and the biological data, together with the length distribution of the catches taken per quarter by the Irish fleet, are shown in Tables 6.1.3 and 6.1.4 respectively. Sampling of catches throughout 1998 was maintained at a satisfactory rate.

6.2 Mean Weights at Age

The mean weights (g) at age in the catches in 1998 are based mainly on Irish samples, together with two Dutch samples. The mean weights from 1970–1998 are shown in Table 6.2.1. The mean weights in 1998 are slightly lower than those of 1997 and may be as a result of the increased proportion of the total catch which was taken in the first quarter.

The mean weights at age for spawning stock for this area have always been calculated for 1 October and have in recent years been based on Irish samples of prespawning fish taken during the fourth Quarter. In 1998 the Working Group suggested that, as the spawning period for the stocks in the area extends from October to following March, it would be more appropriate to use mean weights calculated over the equivalent period. It was also suggested that these mean weights should be presented for a number of recent seasons. The appropriate data is now available for the 1996–1998 seasons and has been used in the VPA. The full data set is shown in Table 6.2.2.

6.3 Ground fish Surveys

Ground fish surveys have been carried out during November along the west coast of Ireland from 1993 to 1998. More than 60 stations have been sampled each year with a bottom trawl fitted with fine mesh liner. Although these surveys are designed to obtain an abundance index for demersal fish it is hoped that they will also provide recruitment indices for herring. However, the data has not yet been properly evaluated.

6.4 Stock surveys

No acoustic surveys have been carried out on this stock in 1998 and there is no fishery independent method of stock assessment.

It is important, however, that acoustic surveys should be resumed because at present there is no other method of assessing the stock size and no basis for providing accurate management advice. As pointed out in the previous report herring fisheries are extremely important to the local communities along the Irish coast and there is an extremely high catching capacity of the fleet in the area.

6.5 State of the Stock

Analytical assessments have not been carried out on this stock for a number of years because of the absence of survey data. Recent Working Groups have therefore only carried out VPA analyses to study the development of the stock and no stock projections have been made. The results of those analyses have indicated that the stock has decreased in recent years from a high level in 1988. This high level was as the result of recruitment of the exceptionally strong 1985 year class which dominated the catches in this area for a long period. In 1998 the Working Group carried out an analysis of the relationship between estimates of recruitment and terminal F in order to define a range of consistent F's to be used in the assessment. The analysis indicated that either recruitment had been exceptional in 1997 or there had been a considerable increase in fishing mortality. Indications from the fishery and the catch in numbers at age suggested that the latter was the more likely conclusion. Because of the two components present in the stock and the apparent increase in the proportionate abundance of the winter/spring component the Working Group suggested that an evaluation of the age compositions of the autumn and winter/spring spawning components should be carried out separately in order to determine if both components are declining at the same rate. It was therefore decided that separable VPAs should be carried out on the age compositions of both components over the period 1970–1998 using a range of terminal Fs. A number of assumptions had to be made on splitting the catches and on the biological data.

Winter/ Spring Spawners

It was assumed that all the Irish catches, that had been taken in the first quarter would have belonged to the winter/spring component. The Irish fishery in this quarter has in recent years been based on spawning fish and an examination of the maturity data indicated that only small amounts of spent fish were present and these would have been from the autumn spawning component. A new set of mean weights at age in the stock was calculated for the winter/spring spawners based on data from recent years. As the fishery takes place on the spawning component these weights were also used for the catches and in the absence of other data, were used to cover the entire time period back to 1970. The proportions of F and M before spawning were assumed to be 0.1. and the maturity ogive was assumed to be the same as that of the autumn spawning component.

The catch data showed that there has been a very dramatic increase in catches from this component. Catches during the early years (1970 to 1980) were comparatively small and usually between 2,000 t-3,000 t. However after 1980 they increased and constituted a significant portion of the total catch in recent years. Catches in 1998 at nearly 18,000 t constituted nearly 46% of the total catch compared with 6,300 t in 1997.

Autumn Spawners

It was assumed that all catches taken throughout the 2 nd, 3rd, and 4 th quarters belonged to the autumn spawning component. The mean weights in catches and other biological parameters in the stock were assumed to be the same as those used in previous assessments of the combined components. Adjustments were made to the proportions of F before spawning to allow for the removal of the winter/spring-spawning component.

This component dominated the catches taken in earlier years but has declined in importance in recent years. From 1980 to 1990 the autumn spawning component constituted about 90% of the total catch. However this figure has decreased to 78% over the period 1991 to 1997 and dropped further in 1998 to 54%.

Results of assessment

The catches in number of the autumn and winter/spring spawning components, for the period 1970 – 1998 are shown in Tables 6.5.1 and 6.5.2.

The Working Group carried out separable VPAs on both components with a range of terminal F values. The period of the separable constraint was fixed for 6 years and the selection on the oldest age groups was set equal to that on the reference age 4. The main features that emerge from the different analyses (SSB, Recruitment & F) are shown in Figs 6.5.1 - 6.5.3. The results show the development of the different components and the overall stock using different input F values in 1998 over a range from 0.3 to 1.1

The total stock has declined dramatically since the high peak attained in 1988 due to the recruitment of the very strong 1985 year class (Figure 6.5.1). This decline is very evident in the dramatic decrease in the numbers of older fish present in the catches in recent years. The decline has continued until 1996 under all assumptions of terminal F values assumed for 1998. There are some indications of an increase in stock since 1996 if F values in 1998 were lower than 0.5. Only two strong year classes have recruited to the stock since 1970 (Figure 6.5.2) -those of 1979 and 1985. There are some indications that 1995 year class may have been strong. This year class showed up as reasonably abundant in the 1997 catches of 1 w.ring fish and was also abundant in the 1998 catches. The F values (Figure 6.5.3) have been steadily increasing since 1989. The values decreased slightly in 1997 but the overall time trend would indicate that a severe decline has taken place in stock size.

The trends in these parameters for the autumn spawning component are very similar to those of the total stock particularly in the earlier years. This is to be expected as in this period the autumn spawners dominated the overall stock. The Fs (Figure 6.5.3) in recent years have increased to very high values.

The size of the winter/spring spawning component (Figure 6.5.1) has been very low up to 1988/89. It then apparently doubled and remained at about the same level up to 1994. Since then it appears to have increased but the apparent increase depends on the assumed F value in 1998. The size of the SSB cannot be determined but if the F in 1998 was around 0.6 then the SSB would have been around 50,000 t. This would mean that it constitutes a large proportion of the total stock at present. The F values for the winter/spring spawners (Figure 6.5.3) have fluctuated erratically over the time period with no overall trend although there does appear to have been an increase from 1989 to 1996. The two fold increase in catch in 1998, compared with that of 1997, must have produced a corresponding large increase in F - otherwise there would have been large changes in the age distribution of the catches (this is not evident in the data

Tables 6.5.1 and 6.5.2). Recruitment over the time period shows the influx of the very strong 1985 year class and also to a lesser extent the 1981 year class. This is also similar to the recruitment pattern in the autumn spawning component

Conclusions

The overall conclusions of these analyses suggest that there may not in fact be two separate stock components given the similarity in recruitment and age distributions. The increase in the winter/spring spawners may be due to a gradual change in spawning time rather than the emergence of a new spawning component. However it must be stressed that this analysis is based on preliminary data.

The conclusions arrived at by the 1998 Working Group, which examined the relationship between recruitment and terminal F were that either

- there must have been a dramatic increase in recruitment to this stock in 1997 or
- there must have been a large increase in fishing mortality.

Although there appears to have been some increase in numbers of young fish in the 1997 and 1998 catches there does not appear to have been any indication of a very strong year class such as the 1985 one. The Working Group therefore concluded that there has been a serious decline in the stock size and an increase in fishing mortality. The results of the present analysis are consistent with those obtained in 1998. There are, however, some further indications that the 1995 year class may be stronger than those of recent years as it also appears to be abundant in the 1998 catches. An increase in catches of young fish from the stock in 1997 and 1998 could have been the result of a change in fishing pattern in which young fish were targeted but this is unlikely in the present era of depressed markets. It therefore appears likely that the stock in this area has, as has been suggested by recent Working Groups, decreased substantially and that mortality has increased. It is difficult to decide what is the present size of the stock but it appears to have declined from a high value of around 300,000 t in 1989 to somewhere between 100,000 t -150,000 t in 1995.

There is no objective method of selecting an appropriate terminal F for 1998 without catch independent supporting data. However the Working Group felt that F in 1998 could not have been lower than the assumed value of 0.6 in 1998. This value was however based on similar types of analyses. In an effort to show the development of the stock at a continuation of this fishing mortality a projection was done on the populations that are calculated from the SVPA with terminal F = 0.6. The results of this analysis are shown in Tables 6.5.3 -6.5.4.

The SSB estimated in 1998 was 80,300 t compared with a peak value of 305,000 t in 1988. There have been no year clasps of comparative strengths to that of 1985 and the F values have increased continually. The estimate of stock size is higher than that estimated in 1998 which implies either that the recruitment in 1998 has increased the stock considerably or that F in 1998 must be higher than he assumed value of 0.6.

6.6 Stock Forecasts and Catch Predictions

Although the size of the stock is by no means certain and must be treated with caution a prediction was carried out under the following assumptions.

The SSB in 1998 was about 80,300 t. Population numbers at 1 January 1999 were taken from the output of the SVPA. The recruitment was taken as the geometric mean over the period 1986 to 1996. The value (787 million 1 w.ring fishes) is considerably higher than the value used in 1998 of 583 million which was incorrectly estimated. Mean weights in the stock and the catches were taken as the average of the last five years. The number of 2 w. ring fish in the population at 1 January 1999, which was generated by the catches of 1 w. ring fish in 1998, was replaced by the geometric mean.

If an F in 1999 is equal to that of the assumed 1998 value of 0.6 then the SSB in 1999 will be 75,400 t and the catches will be around 35,600 t. A continuation of this fishing level in 2000 and 2002 will produce catches of about 32,600 t and the SSB will decline to 72,000 in 2000 and 70 500 t in 2001.

If the catches in 1999 are restricted to the agreed TAC of 21,000 t then the SSB will increase to 87,300 t. A similar TAC in 1999 will lead to a further increase of the SSB to over 96,000 t in 2000 and 102,000 t in 2001.

It must be stressed that these predictions are based on a very uncertain assessment and the F values may, in fact, be considerably higher than those assumed.

If catches in 1999 are as high as those of 1998 then the SSB will decline unless the catches in 2000 are reduced to below 24,000 t.

The input data, used in the predictions and the results are shown in Tables 6.6.1 to 6.6.4. The stock and recruitment plot is shown Figure 6.6.1.

6.7 Management Considerations

Precautionary approach

The results of these non-analytical assessments indicate that the spawning stock has declined considerably in recent years and is now at a comparatively low level. This is consistent with observations from fishermen who in recent years have expressed alarm at the scarcity of herring in this area. There has been no substantial recruitment to the stock in recent years and the very strong 1985 year class has now reached the end of it's natural lifespan. The scarcity of herring may be due to a combination of the decline in stock accentuated by a more northerly distribution of the stock in recent years. It is also interesting to note the increasing importance of winter/spring spawning fish in this area. The old traditional fisheries in this area, which were extremely important in the early part of the century, were all based on winter/spring spawning herring.

Precautionary reference points. The precautionary reference points in relation to this stock are discussed in Section 1.7. It is clear that recruitment does not show any clear dependence on the SSB and that apart from the very high 1985 year class has been quite stable. The suggested Floss value is about 0.33 and the Fpa may be about 0.22. The present analysis, uncertain though it is, indicates that the stock is well below the Bpa (110,000 t) and that the fishing mortality is well above the $F_{pa.} = 0.22$.

6.8 Medium Term Projections and Management considerations

It has not been possible to carry out medium term projections for this stock because of the absence of information. It appears necessary that urgent management measures are required to reduce the catches as soon as possible to below 20,000 t. More specific advice will not be possible until more information becomes available on stock sizes.

Table 6.1.1 Estimated Herring catches in tonnes in Divisions VIa (South) and VIIb,c, 1987–1998. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1987	1988	1989	1990	1991	1992
France	-	-	-	+	-	-
Germany, Fed.Rep.	-	-	-	-	-	250
Ireland	15,000	15,000	18,200	25,000	22,500	26,000
Netherlands	1,550	300	2,900	2,533	600	900
UK (N.Ireland)	5	-	-	80	-	-
UK (England + Wales)	51	-	-	-	-	-
UK Scotland	-	-	+	-	+	-
Unallocated	31,994	13,800	7,100	13,826	11,200	4,600
Total landings	48,600	29,100	28,200	41,439	34,300	31,750
Discards	-	-	1,000	2,530	3,400	100
Total catch	48,600	29,100	29,200	43,969	37,700	31,850

Country	1993	1994	1995	1996	1997	1998[1]
France	-	-	-	-	-	-
Germany, Fed.Rep.	-	-	11	-		-
Ireland	27,600	24,400	25,450	23,800	24,400	25,200
Netherlands	2,500	2,500	1,207	1,800	3,400	2,500
UK (N.Ireland)	-	-	-	-		-
UK (England + Wales)	-	50	24	-		-
UK (Scotland)	200	-	-	-		-
Unallocated	6,250	6,250	1,100	6,900	-700	11,200
Total landings	36,550	33,200	27,792	32,500	27,100	38,900
Discards	250	700	-	-	50	-
Total catch	36,800	33,900	27,792	32,500	27,150	38,900

[1]Provisional according to text.

Table 6.1.2

The SAS System 12:59 Tuesday, March 23, 1999

HER-IRLW: Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

CANUM01: Catch in Numbers (Total International Catch) (Total) (Thousands)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0	135	35114	26007	13243	3895	40181	2982	1667	1911
1971	0	883	6177	7038	10856	8826	3938	40553	2286	2160
1972	0	1001	28786	20534	6191	11145	10057	4243	47182	4305
1973	46	6423	40390	47389	16863	7432	12383	9191	1969	50980
1974	0	3374	29406	41116	44579	17857	8882	10901	10272	30548
1975	194	7360	41308	25117	29192	23718	10703	5909	9378	32029
1976	823	16613	29011	37512	26544	25317	15000	5208	3596	15703
1977	0	4485	44512	13396	17176	12209	9924	5534	1360	4150
1978	82	10170	40320	27079	13308	10685	5356	4270	3638	3324
1979	4	5919	50071	19161	19969	9349	8422	5443	4423	4090
1980	0	2856	40058	64946	25140	22126	7748	6946	4344	5234
1981	0	1620	22265	41794	31460	12812	12746	3461	2735	5220
1982	0	748	18136	17004	28220	18280	8121	4089	3249	2875
1983	0	1517	43688	49534	25316	31782	18320	6695	3329	4251
1984	0	2794	81481	28660	17854	7190	12836	5974	2008	4020
1985	0	9606	15143	67355	12756	11241	7638	9185	7587	2168
1986	0	918	27110	24818	66383	14644	7988	5696	5422	2127
1987	0	12149	44160	80213	41504	99222	15226	12639	6082	10187
1988	0	0	29135	46300	41008	23381	45692	6946	2482	1964
1989	0	2241	6919	78842	26149	21481	15008	24917	4213	3036
1990	0	878	24977	19500	151978	24362	20164	16314	8184	1130
1991	0	675	34437	27810	12420	100444	17921	14865	11311	7660
1992	0	2592	15519	42532	26839	12565	73307	8535	8203	6286
1993	0	191	20562	22666	41967	23379	13547	67265	7671	6013
1994	0	11709	56156	31225	16877	21772	13644	8597	31729	10093
1995	0	284	34471	35414	18617	19133	16081	5749	8585	14215
1996	43	4776	24424	69307	31128	9842	15314	8158	12463	6472
1997	0	7458	56329	25946	38742	14583	5977	8351	3418	4264
1998	0	7437	72777	80612	38326	30165	9138	5282	3434	2942

Table 6.1.3 Divisions VIa (South) and VIIb. Sampling intensity of catches in 1998.

Country	Q	Catch[1]	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t.	Estimate of discards
Ireland	1	17765	17	747	3010	42	No
	2	101	0	0	0	-	No
	3	2813	3	150	860	53	No
	4	15378	14	447	3338	28	No
Netherlands	3	2476	1	50	-	20	No

[1]including Division VIa (North).

Table 6.1.4 Divisions VIa and VIIb. Length distributions of Irish catches (pelagic trawlers) per quarter (10^3) in 1998.

Length	Q1	Q2	Q3	Q4
18.0				
18.5				
19.0				
19.5				24
20.0		33	21	170
20.5		33	21	436
21.0		67	105	824
21.5		67	210	1139
22.0		433	461	1526
22.5		233	252	1696
23.0		800	420	2350
23.5		1000	378	3126
24.0		2899	944	7778
24.5		4265	1259	9643
25.0		7998	2790	14174
25.5		8398	2202	1158
26.0		11564	3272	14538
26.5		9464	2035	9837
27.0		10864	1489	9643
27.5		9264	818	4991
28.0		11630	461	4289
28.5		10064	315	2690
29.0		7931	252	2835
29.5		4732	168	1405
30.0		3899	147	993
30.5		1700	21	557
31.0		1600		170
31.5		766		24
32.0		833		24
32.5		300		
33.0		200		
33.5		167		
34.0		33		
34.5				
35.0				
Total		111237	0	18039	96041

Table 6.2.1

WECA01: Mean Weight in Catch (Total International Catch) (Total) (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1971	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1972	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1973	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1974	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1975	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1976	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1977	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1978	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1979	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1980	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1981	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1982	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1983	-1.000	0.090	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1984	-1.000	0.106	0.141	0.181	0.210	0.226	0.237	0.243	0.247	0.248
1985	-1.000	0.077	0.122	0.161	0.184	0.196	0.206	0.212	0.225	0.230
1986	-1.000	0.095	0.138	0.164	0.194	0.212	0.225	0.239	0.208	0.288
1987	-1.000	0.085	0.102	0.150	0.169	0.177	0.193	0.205	0.215	0.220
1988	-1.000	-1.000	0.098	0.133	0.153	0.166	0.171	0.183	0.191	0.201
1989	-1.000	0.080	0.130	0.141	0.164	0.174	0.183	0.192	0.193	0.203
1990	-1.000	0.094	0.138	0.148	0.160	0.176	0.189	0.194	0.208	0.216
1991	-1.000	0.089	0.134	0.145	0.157	0.167	0.185	0.199	0.207	0.230
1992	-1.000	0.095	0.141	0.147	0.157	0.165	0.171	0.180	0.194	0.219
1993	-1.000	0.112	0.138	0.153	0.170	0.181	0.184	0.196	0.229	0.236
1994	-1.000	0.081	0.141	0.164	0.177	0.189	0.187	0.191	0.204	0.220
1995	-1.000	0.080	0.140	0.161	0.173	0.182	0.198	0.194	0.206	0.217
1996	.	0.085	0.135	0.172	0.182	0.199	0.209	0.220	0.233	0.237
1997	.	0.093	0.135	0.155	0.181	0.201	0.217	0.217	0.231	0.239
1998	0.005	0.095	0.136	0.145	0.173	0.191	0.196	0.202	0.222	0.217

Table 6.2.2

The SAS System 13:36 Tuesday, March 23, 1999
HER-IRLW: Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

WEST01: Mean Weight in Stock (Total International Catch) (Total) (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1971	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1972	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1973	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1974	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1975	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1976	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1977	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1978	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1979	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1980	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1981	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1982	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1983	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1984	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1985	-1.000	0.100	0.150	0.196	0.227	0.238	0.251	0.252	0.269	0.284
1986	-1.000	0.098	0.169	0.209	0.238	0.256	0.276	0.280	0.287	0.312
1987	-1.000	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1988	-1.000	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1989	-1.000	0.138	0.157	0.168	0.182	0.200	0.217	0.227	0.238	0.245
1990	-1.000	0.113	0.152	0.170	0.180	0.200	0.217	0.225	0.233	0.255
1991	-1.000	0.102	0.149	0.174	0.190	0.195	0.206	0.226	0.236	0.248
1992	-1.000	0.102	0.144	0.167	0.182	0.194	0.197	0.214	0.218	0.242
1993	-1.000	0.118	0.166	0.196	0.205	0.214	0.220	0.223	0.242	0.258
1994	-1.000	0.098	0.156	0.192	0.209	0.216	0.223	0.226	0.230	0.247
1995	-1.000	0.090	0.144	0.181	0.203	0.217	0.226	0.227	0.239	0.246
1996	.	0.086	0.137	0.186	0.206	0.219	0.234	0.233	0.249	0.253
1997	.	0.094	0.135	0.169	0.194	0.210	0.224	0.231	0.230	0.239
1998	0.005	0.095	0.136	0.145	0.173	0.191	0.196	0.202	0.222	0.217

Table 6.5.2

The SAS System 15:48 Tuesday, March 23, 1999

HER-IRWS: Herring spring spawners west of Ireland and Porcupne Bank (Vla South)

CANUM01 : Catch in Numbers (Total International Catch Thousands)

Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
0	1243	1285	1243	1682	857	2121	878	1139
0	1318	3695	2697	998	1232	727	690	961
67	614	814	2921	2961	1774	2107	1094	987
52	2004	2408	1321	2564	1640	612	2004	416
0	290	490	256	273	437	256	110	327
0	202	592	437	693	515	400	487	342
144	2939	2609	2572	3133	2004	387	570	1953
436	1532	3083	2892	2444	1523	767	269	700
1046	1965	2362	3684	2192	1750	1023	941	1186
10	625	940	1115	450	178	138	101	163
0	113	923	454	690	118	246	93	74
0	7640	4955	3555	618	667	68	201	816
0	96	186	870	1174	241	282	215	144
62	2380	14035	7989	6826	4621	3159	1439	1172
105	7412	6194	2385	566	2393	1743	421	428
0	198	787	1368	886	1528	844	516	308
0	454	5328	9033	3022	1225	635	1407	223
4909	8743	11135	6271	14788	2000	1537	454	780
0	5177	4013	7412	5156	9386	1761	526	418
1152	156	12749	1532	1829	1400	1307	208	413
544	405	1042	12632	1865	1861	1878	757	216
1140	2608	5615	3514	33241	4911	3990	3142	618
533	370	5346	3773	3425	15679	2617	1617	887
0	3609	8151	16294	6651	4685	18767	1623	1518
0	2245	5712	4852	6103	3535	3398	6745	1489
0	257	6975	5047	6698	4170	1350	2279	1976
0	509	29643	13749	3261	9521	1643	716	750
0	258	8208	15934	5583	1913	4749	608	467
0	1622	48054	25764	20991	5916	4403	2758	1730

Table 6.5.3

Run title : Herring VIa South (run: SEPKGF05/S05)

At 19-Mar-99 17:53:58

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE									
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0002,	.0008,	.0000,	.0000,
1,	.0005,	.0017,	.0022,	.0192,	.0091,	.0288,	.0389,	.0122,	.0153,
2,	.3817,	.0490,	.1172,	.1894,	.1940,	.2495,	.2588,	.2364,	.2470,
3,	.2410,	.1287,	.2411,	.3048,	.3189,	.2685,	.4020,	.1936,	.2347,
4,	.1763,	.1424,	.1516,	.3023,	.4949,	.3723,	.4761,	.3074,	.2839,
5,	.1659,	.1532,	.1906,	.2445,	.5314,	.4726,	.5651,	.3714,	.2843,
6,	.1454,	.2251,	.2336,	.2979,	.4545,	.6241,	.5482,	.3998,	.2463,
7,	.1878,	.1917,	.3572,	.3087,	.4115,	.5495,	.6273,	.3541,	.2665,
8,	.2334,	.1924,	.3167,	.2489,	.5900,	.6599,	.6775,	.2911,	.3691,
+gp,	.2334,	.1924,	.3167,	.2489,	.5900,	.6599,	.6775,	.2911,	.3691,
0 FBAR 3- 6,	.1822,	.1623,	.2042,	.2874,	.4499,	.4344,	.4978,	.3180,	.2623,

Table 8 Fishing mortality (F) at age YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0095,	.0085,	.0037,	.0017,	.0010,	.0047,	.0124,	.0016,	.0058,	.0000,
2,	.1627,	.1374,	.1416,	.0870,	.2137,	.1161,	.0515,	.0724,	.1652,	.0282,
3,	.1885,	.3487,	.2203,	.1620,	.3827,	.2249,	.1405,	.1182,	.3349,	.2774,
4,	.2579,	.3808,	.2691,	.2157,	.3632,	.2186,	.1403,	.1900,	.2797,	.2710,
5,	.2941,	.4459,	.3027,	.2211,	.3555,	.1481,	.1864,	.2119,	.4231,	.2244,
6,	.3373,	.3754,	.4427,	.2846,	.3199,	.2117,	.2075,	.1755,	.3161,	.3124,
7,	.3758,	.4547,	.2551,	.2204,	.3563,	.1463,	.2064,	.2107,	.4077,	.2077,
8,	.4295,	.5140,	.2888,	.3584,	.2508,	.1533,	.2496,	.1620,	.3238,	.1160,
+gp,	.4295,	.5140,	.2888,	.3584,	.2508,	.1533,	.2496,	.1620,	.3238,	.1160,
0 FBAR 3- 6,	.2695,	.3877,	.3087,	.2208,	.3553,	.2008,	.1687,	.1739,	.3385,	.2713,

1

Run title : Herring VIa South (run: SEPKGF05/S05)

At 19-Mar-99 17:53:58

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	FBAR 96-98
AGE											
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0049,	.0017,	.0020,	.0093,	.0004,	.0201,	.0009,	.0074,	.0111,	.0189,	.0125,
2,	.0421,	.1146,	.1410,	.0979,	.1595,	.3018,	.1262,	.1617,	.1914,	.2431,	.1987,
3,	.1049,	.1692,	.1910,	.2749,	.2144,	.4110,	.3375,	.4254,	.2740,	.4896,	.3963,
4,	.2365,	.2848,	.1471,	.2699,	.4516,	.2325,	.4364,	.5292,	.4246,	.7781,	.5773,
5,	.1988,	.3209,	.2753,	.1950,	.3540,	.3967,	.3968,	.3854,	.4485,	.6061,	.4800,
6,	.1966,	.2589,	.3674,	.2952,	.2962,	.3202,	.5060,	.5625,	.3792,	.4973,	.4797,
7,	.2499,	.3022,	.2754,	.2665,	.4275,	.2768,	.1935,	.4610,	.6068,	.5971,	.5550,
8,	.1582,	.1089,	.3152,	.2150,	.3610,	.3261,	.4331,	.7119,	.3168,	.4775,	.5021,
+gp,	.1582,	.1089,	.3152,	.2150,	.3610,	.3261,	.4331,	.7119,	.3168,	.4775,	
0 FBAR 3- 6,	.1842,	.2585,	.2452,	.2587,	.3290,	.3401,	.4192,	.4756,	.3816,	.5928,	

1

Run title : Herring VIa South (run: SEPKGF05/S05)

At 19-Mar-99 17:53:58

Traditional vpa Terminal populations from weighted Separable populations

Table 6.5.3 continued

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE									
0,	222399,	199662,	144660,	160452,	111282,	186893,	158664,	288420,	268426,
1,	40611,	81816,	73451,	53218,	59024,	40938,	68743,	58322,	106104,
2,	12690,	14932,	30047,	26963,	19204,	21518,	14633,	24325,	21194,
3,	13344,	6418,	10533,	19798,	16528,	11718,	12420,	8369,	14226,
4,	8598,	8585,	4620,	6776,	11950,	9837,	7335,	6803,	5645,
5,	2673,	6522,	6737,	3593,	4532,	6592,	6134,	4123,	4527,
6,	31171,	2049,	5063,	5038,	2546,	2410,	3718,	3154,	2573,
7,	1827,	24389,	1480,	3627,	3384,	1462,	1168,	1944,	1914,
8,	840,	1370,	18218,	937,	2410,	2029,	764,	565,	1235,
+gp,	963,	1295,	1662,	24262,	7168,	6929,	3335,	1723,	1128,
0 TOTAL,	335115,	347038,	296473,	304665,	238029,	290326,	276914,	397746,	426973,

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
0,	144969,	186517,	193526,	634399,	258667,	335702,	247360,	899940,	143366,	197690,
1,	98744,	53331,	68616,	71194,	233382,	95158,	123498,	90999,	331069,	52741,
2,	38442,	35982,	19453,	25148,	26147,	85768,	34844,	44874,	33423,	121087,
3,	12265,	24203,	23233,	12509,	17078,	15644,	56572,	24516,	30923,	20989,
4,	9211,	8316,	13982,	15260,	8709,	9536,	10229,	40247,	17835,	18112,
5,	3846,	6440,	5142,	9667,	11129,	5481,	6934,	8044,	30115,	12200,
6,	3082,	2593,	3731,	3438,	7012,	7057,	4276,	5207,	5889,	17848,
7,	1820,	1990,	1612,	2168,	2340,	4608,	5167,	3144,	3953,	3884,
8,	1326,	1131,	1143,	1130,	1574,	1483,	3602,	3804,	2305,	2379,
+gp,	1227,	1389,	2182,	1000,	2010,	2968,	1029,	1492,	3860,	1883,
0 TOTAL,	314932,	321891,	332620,	775913,	568049,	563405,	493512,	1122266,	602737,	448814,

1

Run title : Herring VIa South (run: SEPKGP05/S05)

At 19-Mar-99 17:53:58

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	GMST 70-96	AMST 70-96
AGE													
0,	223605,	142335,	119905,	183054,	252996,	139507,	277303,	289847,	171014,	0,	0,	215026,	244872,
1,	72726,	82260,	52359,	44111,	67342,	93072,	51322,	102014,	106626,	62912,	0,	76222,	87636,
2,	19402,	26624,	30211,	19223,	16977,	24763,	33559,	18864,	37251,	38792,	22712,	26757,	31089,
3,	87207,	13781,	17588,	19438,	12913,	10154,	13565,	21914,	11889,	22789,	23535,	17012,	20291,
4,	13022,	64289,	9526,	11896,	12090,	8532,	5512,	7925,	11725,	7400,	11435,	10680,	13125,
5,	12498,	9301,	43755,	7440,	8217,	5964,	5118,	3223,	4224,	6939,	3075,	7096,	8961,
6,	8820,	9269,	6106,	30062,	5540,	5219,	4238,	3723,	1984,	2441,	3425,	5225,	7068,
7,	11816,	6556,	6474,	3826,	20248,	3727,	3428,	2312,	1919,	1228,	1343,	3387,	4825,
8,	2855,	8328,	4385,	4448,	2652,	11948,	2557,	2556,	1319,	947,	612,	2196,	3258,
+gp,	2058,	1150,	2970,	2408,	2079,	3801,	4234,	1328,	1648,	811,	987,		
0 TOTAL,	454009,	363885,	293273,	326905,	400153,	307687,	401837,	453706,	349598,	144260,	66123,		

1

Run title : Herring VIa South (run: SEPKGP05/S05)

At 19-Mar-99 17:53:58

Traditional vpa Terminal populations from weighted Separable populations

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE									
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	80372,	118185,	227204,	194248,	137925,	148900,	100633,	169811,	146914,
3,	99298,	51497,	78378,	141167,	116744,	85610,	82980,	64286,	106315,
4,	71447,	72979,	39037,	51752,	80217,	71686,	49860,	51779,	43652,
5,	22368,	55045,	55449,	28522,	29685,	44914,	39284,	30063,	34990,
6,	264461,	16478,	40492,	38587,	17556,	14837,	24082,	22567,	20404,
7,	15067,	200594,	10897,	27583,	24020,	9462,	7177,	14344,	14969,
8,	6716,	11264,	137807,	7417,	15181,	12194,	4536,	4344,	9017,
+gp,	7700,	10643,	12574,	192048,	45148,	41646,	19807,	13256,	8239,

Table 6.5.3 continued.

```
        Table 11    Spawning stock number at age (spawning time)      Numbers*10**-3
        YEAR,        1979,    1980,    1981,    1982,    1983,    1984,    1985,    1986,    1987,    1988,

        AGE
          0,            0,       0,       0,       0,       0,       0,       0,       0,       0,       0,
          1,            0,       0,       0,       0,       0,       0,       0,       0,       0,       0,
          2,       281951,  268406,  144711,  194047,  185340,  648996,  275320,  349659,  244724,  971831,
          3,        94540,  167577,  175303,   98147,  115583,  117687,  450331,  198094,  216085,  152435,
          4,        72469,   60262,  109192,  123509,   63859,   77032,   87080,  331397,  138290,  141255,
          5,        29533,   44671,   39261,   77960,   82018,   46413,   57235,   65272,  212112,   98171,
          6,        22994,   18858,   25935,   26568,   52926,   57269,   34803,   43296,   44561,  135390,
          7,        13232,   13726,   12707,   17493,   17237,   39068,   42082,   25534,   28134,   31607,
          8,         9303,    7495,    8809,    8313,   12442,   12513,   28497,   31911,   17349,   20588,
        +gp,         8602,    9203,   16813,    7356,   15887,   25051,    8143,   12518,   29059,   16292,
1
Run title : Herring VIa South (run: SEPKGF05/S05)

    At 19-Mar-99  17:53:58

                  Traditional vpa  Terminal populations from weighted Separable populations

        Table 11    Spawning stock number at age (spawning time)      Numbers*10**-3
        YEAR,        1989,    1990,    1991,    1992,    1993,    1994,    1995,    1996,    1997,    1998,

        AGE
          0,            0,       0,       0,       0,       0,       0,       0,       0,       0,       0,
          1,            0,       0,       0,       0,       0,       0,       0,       0,       0,       0,
          2,       154280,  201667,  224828,  147246,  118163,  165455,  252235,  138451,  268012,  269586,
          3,       710943,  107608,  135341,  141410,   97823,   67429,   94631,  144130,   86536,  143572,
          4,       103932,  496791,   80726,   92843,   83544,   68281,   38476,   51989,   82503,   41091,
          5,       102301,   70154,  340263,   61059,   60624,   49927,   43862,   23284,   29250,   43232,
          6,        72306,   72882,   44638,  230690,   42481,   39384,   28238,   23884,   14390,   16357,
          7,        93469,   50076,   50344,   29928,  142202,   28958,   28164,   15876,   11953,    7701,
          8,        23858,   72399,   33203,   36016,   19472,   89807,   17891,   14838,    9978,    6429,
        +gp,        17193,    9996,   22486,   27599,   15263,   28568,   29624,    7705,   12448,    5508,
1

Run title : Herring VIa South (run: SEPKGF05/S05)

    At 19-Mar-99  17:53:58

                  Traditional vpa  Terminal populations from weighted Separable populations

        Table 13    Spawning stock biomass at age (spawning time)      Tonnes
        YEAR,        1970,    1971,    1972,    1973,    1974,    1975,    1976,    1977,    1978,

        AGE
          0,            0,       0,       0,       0,       0,       0,       0,       0,       0,
          1,            0,       0,       0,       0,       0,       0,       0,       0,       0,
          2,        13583,   19973,   38398,   32828,   23309,   25164,   17007,   28698,   24828,
          3,        20853,   10814,   16459,   29645,   24516,   17978,   17426,   13500,   22326,
          4,        16862,   17223,    9213,   12214,   18931,   16918,   11767,   12220,   10302,
          5,         5816,   14312,   14417,    7416,    7718,   11678,   10214,    7816,    9097,
          6,        72198,    4499,   11054,   10534,    4793,    4051,    6574,    6161,    5570,
          7,         4264,   56768,    3084,    7806,    6798,    2678,    2031,    4059,    4236,
          8,         1948,    3267,   39964,    2151,    4402,    3536,    1315,    1260,    2615,
        +gp,         2279,    3150,    3722,   56846,   13364,   12327,    5863,    3924,    2439,
0     TOTSPBIO,    137802,  130006,  136310,  159439,  103831,   94330,   72197,   77638,   81414,

      Table 13    Spawning stock biomass at age (spawning time)      Tonnes
        YEAR,        1979,    1980,    1981,    1982,    1983,    1984,    1985,    1986,    1987,    1988,

        AGE
          0,            0,       0,       0,       0,       0,       0,       0,       0,       0,       0,
          1,            0,       0,       0,       0,       0,       0,       0,       0,       0,       0,
          2,        47650,   45361,   24456,   32794,   31322,  109680,   41298,   59092,   40135,  159380,
          3,        19853,   35191,   36814,   20611,   24272,   24714,   88265,   41402,   44514,   31402,
          4,        17103,   14222,   25769,   29148,   15071,   18179,   19767,   78873,   32222,   32912,
          5,         7679,   11614,   10208,   20270,   21325,   12067,   13622,   16710,   53452,   24739,
          6,         6277,    5148,    7080,    7253,   14449,   15634,    8735,   11950,   12076,   36631,
          7,         3745,    3884,    3596,    4951,    4878,   11056,   10605,    7150,    7878,    8850,
          8,         2698,    2174,    2555,    2411,    3608,    3629,    7666,    9158,    5135,    6094,
        +gp,         2546,    2724,    4977,    2177,    4703,    7415,    2313,    3906,    9212,    5164,
0     TOTSPBIO,    107550,  120318,  115454,  119614,  119628,  202376,  192270,  228240,  204623,  305233,
```

Table 6.5.3 continued

Run title : Herring VIa South (run: SEPKGF05/S05)

At 19-Mar-99 17:53:58

Traditional vpa Terminal populations from weighted Separable populations

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	24222,	30653,	33499,	21203,	19615,	25811,	36322,	18968,	36182,	36664,
3,	119438,	18293,	23549,	23615,	19173,	12946,	17128,	26808,	14625,	20818,
4,	18916,	89422,	15338,	16897,	17127,	14271,	7811,	10710,	16006,	7109,
5,	20460,	14031,	66351,	11845,	12973,	10784,	9518,	5099,	6142,	8257,
6,	15690,	15815,	9196,	45446,	9346,	8783,	6382,	5589,	3223,	3206,
7,	21217,	11267,	11378,	6405,	31711,	6544,	6393,	3699,	2761,	1556,
8,	5678,	16869,	7836,	7851,	4712,	20656,	4276,	3695,	2295,	1427,
+gp,	4212,	2549,	5576,	6679,	3938,	7056,	7287,	1949,	2975,	1195,
0 TOTSPBIO,	229834,	198900,	172724,	139943,	118595,	106851,	95117,	76517,	84209,	80232,

1

Table 6.5.4

Run title : Herring VIa South (run: SEPKGF05/S05)

At 19-Mar-99 17:53:58

Table 16 Summary (without SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	BAR 3- 6,
1970	2223992	243234	137801	20306	.1474	.1822
1971	1996618	276497	130006	15044	.1157	.1623
1972	1446602	279692	136310	23474	.1722	.2042
1973	1604523	290935	159439	36719	.2303	.2874
1974	1112818	233840	103831	36589	.3524	.4499
1975	1868931	206253	94330	38764	.4109	.4344
1976	1586642	207970	72197	32767	.4539	.4978
1977	2884197	205136	77638	20567	.2649	.3180
1978	2684265	264314	81414	19715	.2422	.2623
1979	1449690	276492	107550	22608	.2102	.2695
1980	1865174	250755	120318	30124	.2504	.3877
1981	1935264	254243	115454	24922	.2159	.3087
1982	6343990	300548	119614	19209	.1606	.2208
1983	2586665	471748	119628	32988	.2758	.3553
1984	3357016	407709	202376	27450	.1356	.2008
1985	2473604	362736	192270	23343	.1214	.1687
1986	8999396	371384	228239	28785	.1261	.1739
1987	1433656	603184	204623	48600	.2375	.3385
1988	1976898	438181	305233	29100	.0953	.2713
1989	2236053	383827	229834	29210	.1271	.1842
1990	1423264	348374	198900	43969	.2211	.2585
1991	1199050	277368	172724	37700	.2183	.2452
1992	1830539	226574	139943	31856	.2276	.2587
1993	2529959	242951	118595	36763	.3100	.3290
1994	1395068	239141	106851	33908	.3173	.3401
1995	2773035	177421	95117	27792	.2922	.4192
1996	2898469	201544	76517	32534	.4252	.4756
1997	1710139	218072	84209	27225	.3233	.3816
1998	0	182751	80232	38895	.4848	.5928
Arith. Mean	2338811,	291134,	138317,	30032,	.2471,	.3096,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Run title : Herring VIa South (run: SEPKGF05/S05)

At 19-Mar-99 17:53:58

Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 3- 6,
1970,	2223992,	218122,	123574,	20306,	.1643,	.8968,	.1822,
1971,	1996618,	240751,	113199,	15044,	.1329,	.8707,	.1623,
1972,	1446602,	251015,	122334,	23474,	.1919,	.8975,	.2042,
1973,	1604523,	295632,	162014,	36719,	.2266,	1.0161,	.2874,
1974,	1112818,	228268,	101357,	36589,	.3610,	.9762,	.4499,
1975,	1868931,	231745,	105988,	38764,	.3657,	1.1236,	.4344,
1976,	1586642,	217729,	75585,	32767,	.4335,	1.0469,	.4978,
1977,	2884197,	221100,	83680,	20567,	.2458,	1.0778,	.3180,
1978,	2684265,	268570,	82726,	19715,	.2383,	1.0161,	.2623,
1979,	1449690,	294844,	114689,	22608,	.1971,	1.0664,	.2695,
1980,	1865174,	241616,	115933,	30124,	.2598,	.9636,	.3877,
1981,	1935264,	262172,	119055,	24922,	.2093,	1.0312,	.3087,
1982,	6343990,	309584,	123210,	19209,	.1559,	1.0301,	.2208,
1983,	2586665,	473727,	120129,	32988,	.2746,	1.0042,	.3553,
1984,	3357016,	394996,	196065,	27450,	.1400,	.9688,	.2008,
1985,	2473604,	357152,	189311,	23343,	.1233,	.9846,	.1687,
1986,	8999396,	371444,	228276,	28785,	.1261,	1.0002,	.1739,
1987,	1433656,	572287,	194142,	48600,	.2503,	.9488,	.3385,
1988,	1976898,	437852,	305003,	29100,	.0954,	.9992,	.2713,
1989,	2236053,	384201,	230058,	29210,	.1270,	1.0010,	.1842,
1990,	1423264,	348589,	199023,	43969,	.2209,	1.0006,	.2585,
1991,	1199050,	276577,	172231,	37700,	.2189,	.9971,	.2452,
1992,	1830539,	225460,	139255,	31856,	.2288,	.9951,	.2587,
1993,	2529959,	244399,	119302,	36763,	.3081,	1.0060,	.3290,
1994,	1395068,	238662,	106637,	33908,	.3180,	.9980,	.3401,
1995,	2773035,	186735,	100111,	27792,	.2776,	1.0525,	.4192,
1996,	2898469,	200638,	76173,	32534,	.4271,	.9955,	.4756,
1997,	1710139,	218426,	84345,	27225,	.3228,	1.0016,	.3816,
1998,	0,	182522,	80131,	38895,	.4854,	.9988,	.5928,
Arith. Mean	2338811,	289476,	137363,	30032,	.2457		.3096,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 6.6.1

The SAS System 09:15 Tuesday, March 23, 1999
Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

Single option prediction: Input data

Year: 1999

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	787.300	1.0000	0.0000	0.6700	0.6700	0.097	0.0052	0.091
2	227.100	0.3000	1.0000	0.6700	0.6700	0.146	0.2544	0.138
3	225.300	0.2000	1.0000	0.6700	0.6700	0.178	0.4814	0.158
4	114.400	0.1000	1.0000	0.6700	0.6700	0.198	0.6001	0.176
5	30.800	0.1000	1.0000	0.6700	0.6700	0.211	0.6011	0.191
6	34.300	0.1000	1.0000	0.6700	0.6700	0.221	0.6253	0.199
7	13.400	0.1000	1.0000	0.6700	0.6700	0.224	0.5580	0.203
8	6.100	0.1000	1.0000	0.6700	0.6700	0.235	0.6001	0.221
9+	9.900	0.1000	1.0000	0.6700	0.6700	0.245	0.6001	0.228
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2000

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	787.300	1.0000	0.0000	0.6700	0.6700	0.097	0.0052	0.091
2	.	0.3000	1.0000	0.6700	0.6700	0.146	0.2544	0.138
3	.	0.2000	1.0000	0.6700	0.6700	0.178	0.4814	0.158
4	.	0.1000	1.0000	0.6700	0.6700	0.198	0.6001	0.176
5	.	0.1000	1.0000	0.6700	0.6700	0.211	0.6011	0.191
6	.	0.1000	1.0000	0.6700	0.6700	0.221	0.6253	0.199
7	.	0.1000	1.0000	0.6700	0.6700	0.224	0.5580	0.203
8	.	0.1000	1.0000	0.6700	0.6700	0.235	0.6001	0.221
9+	.	0.1000	1.0000	0.6700	0.6700	0.245	0.6001	0.228
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2001

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	787.300	1.0000	0.0000	0.6700	0.6700	0.097	0.0052	0.091
2	.	0.3000	1.0000	0.6700	0.6700	0.146	0.2544	0.138
3	.	0.2000	1.0000	0.6700	0.6700	0.178	0.4814	0.158
4	.	0.1000	1.0000	0.6700	0.6700	0.198	0.6001	0.176
5	.	0.1000	1.0000	0.6700	0.6700	0.211	0.6011	0.191
6	.	0.1000	1.0000	0.6700	0.6700	0.221	0.6253	0.199
7	.	0.1000	1.0000	0.6700	0.6700	0.224	0.5580	0.203
8	.	0.1000	1.0000	0.6700	0.6700	0.235	0.6001	0.221
9+	.	0.1000	1.0000	0.6700	0.6700	0.245	0.6001	0.228
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRCJK01
Date and time: 23MAR99:10:11

Table 6.6.2

The SAS System 09:15 Tuesday, March 23, 1999
Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)
Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.0065	0.6000	216995	35896	1448600	193219	661300	116851	429099	75365
2000	1.0065	0.6000	198740	32806	1422448	186684	635148	110316	416216	71783
2001	1.0065	0.6000	192424	31518	1413692	184332	626392	107964	410740	70300
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRCJK01
Date and time : 23MAR99:10:11
Computation of ref. F: Simple mean, age 4 - 7
Prediction basis : F factors

Table 6.6.3

The SAS System 11:31 Tuesday, March 23, 1999
Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0065	0.6000	193219	75365	35896	0.4000	0.2385	186684	85858	14932	204059	99340
.	.	.	.	.	0.4500	0.2683	.	84587	16606	202205	96395
.	.	.	.	.	0.5000	0.2981	.	83338	18241	200395	93564
.	.	.	.	.	0.5500	0.3279	.	82109	19837	198629	90841
.	.	.	.	.	0.6000	0.3577	.	80900	21396	196905	88224
.	.	.	.	.	0.6500	0.3875	.	79711	22919	195223	85706
.	.	.	.	.	0.7000	0.4173	.	78542	24407	193580	83284
.	.	.	.	.	0.7500	0.4471	.	77392	25860	191977	80953
.	.	.	.	.	0.8000	0.4769	.	76261	27279	190412	78711
.	.	.	.	.	0.8500	0.5067	.	75149	28666	188884	76552
.	.	.	.	.	0.9000	0.5365	.	74054	30022	187393	74474
.	.	.	.	.	0.9500	0.5663	.	72978	31346	185936	72473
.	.	.	.	.	1.0000	0.5961	.	71919	32640	184514	70545
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANCJK01
Date and time : 23MAR99:11:32
Computation of ref. F: Simple mean, age 4 - 7
Basis for 1999 : F factors

Table 6.6.4

The SAS System 11:31 Tuesday, March 23, 1999
Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
0.5285	0.3151	193219	87303	21000	0.4000	0.2385	203124	98868	17802	216374	109134
.	.	.	.	.	0.4500	0.2683	.	97349	19790	214170	105721
.	.	.	.	.	0.5000	0.2981	.	95855	21731	212022	102444
.	.	.	.	.	0.5500	0.3279	.	94387	23625	209927	99298
.	.	.	.	.	0.6000	0.3577	.	92944	25473	207883	96277
.	.	.	.	.	0.6500	0.3875	.	91526	27277	205890	93375
.	.	.	.	.	0.7000	0.4173	.	90131	29038	203946	90587
.	.	.	.	.	0.7500	0.4471	.	88760	30757	202050	87908
.	.	.	.	.	0.8000	0.4769	.	87412	32435	200200	85334
.	.	.	.	.	0.8500	0.5067	.	86087	34073	198396	82859
.	.	.	.	.	0.9000	0.5365	.	84784	35673	196636	80480
.	.	.	.	.	0.9500	0.5663	.	83504	37234	194918	78193
.	.	.	.	.	1.0000	0.5961	.	82244	38759	193243	75993
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANCJK01
Date and time : 23MAR99:11:32
Computation of ref. F: Simple mean, age 4 - 7
Basis for 1999 : TAC constraints

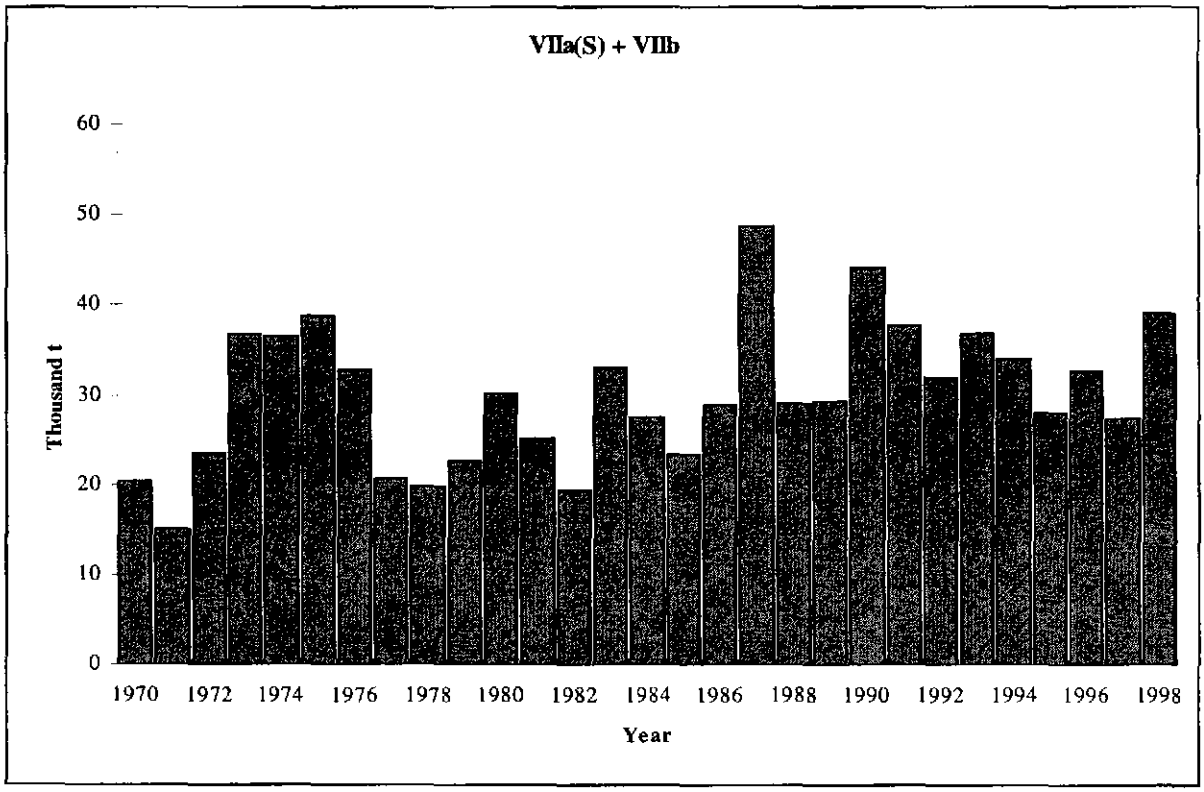


Figure 6.1.1 Herring VIa(S) + VIIb: Catches.

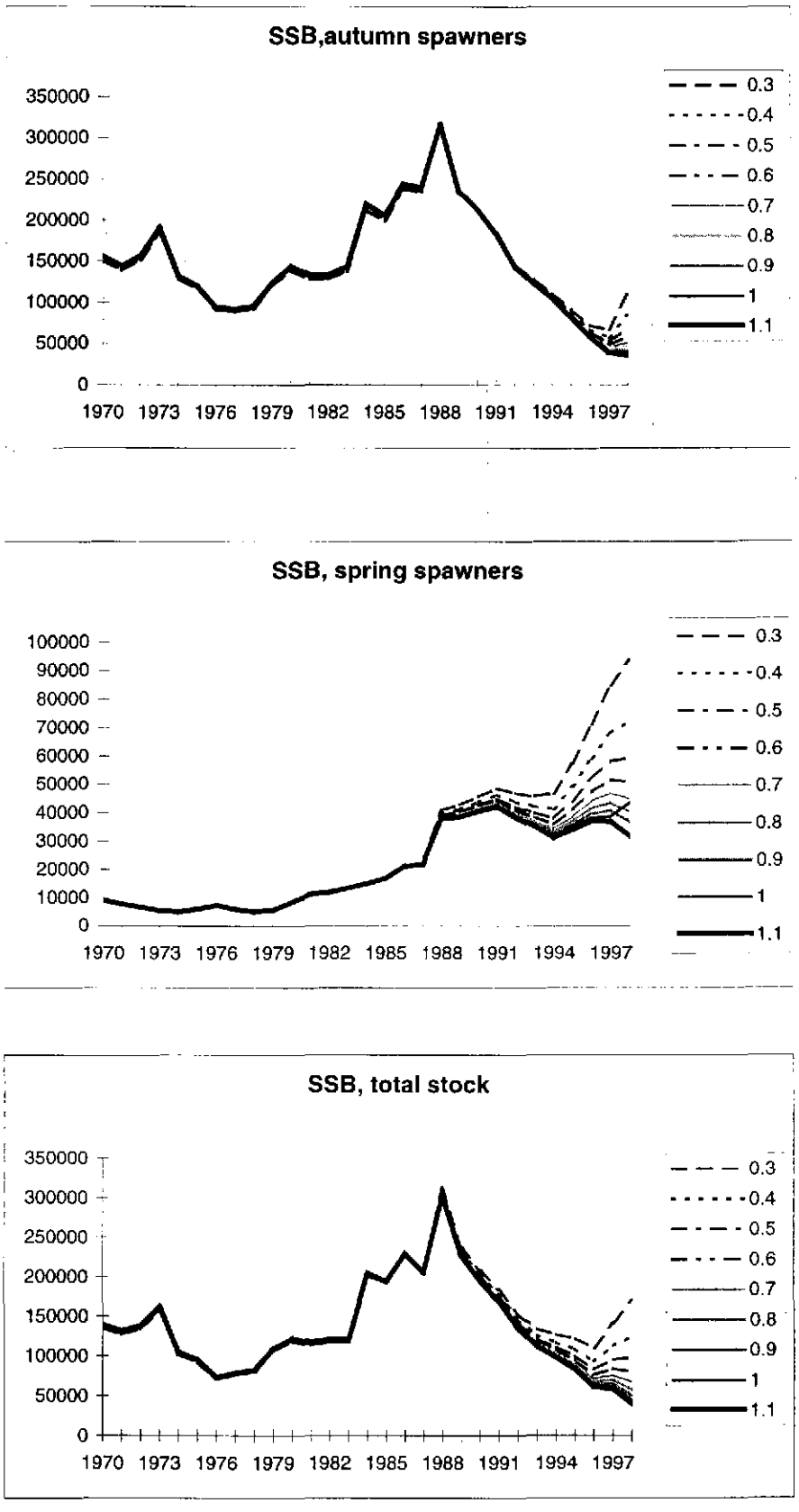
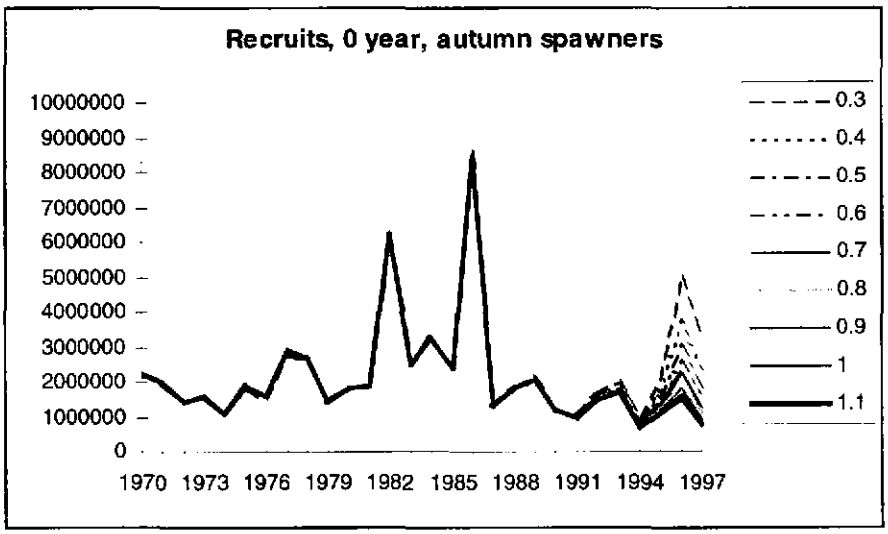
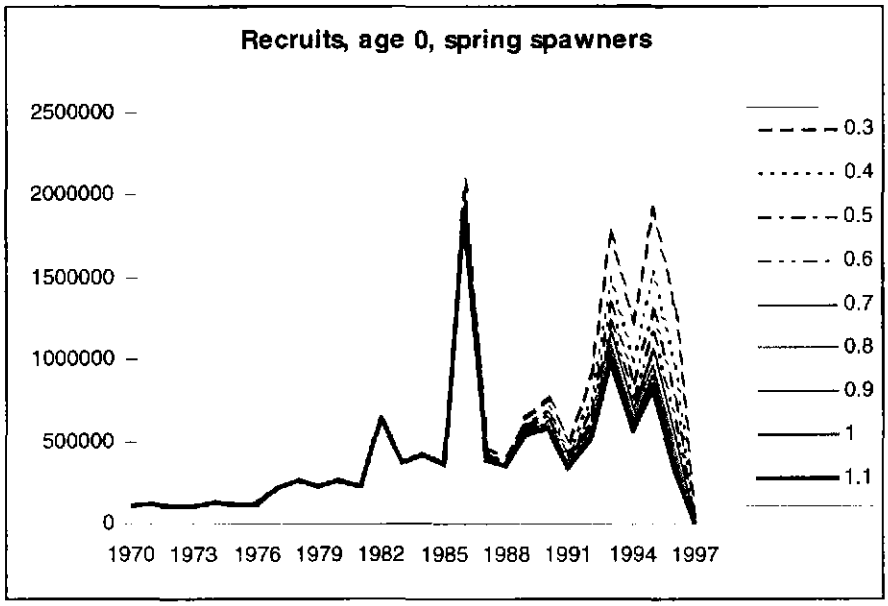


Figure 6.5.1 The spawning stock biomass at spawning time for autumn spawners, spring spawners and spring spawners and autumn spawners as one stock for selected values of terminal F in the separable analysis. Note the different scale of the spring spawner biomass-





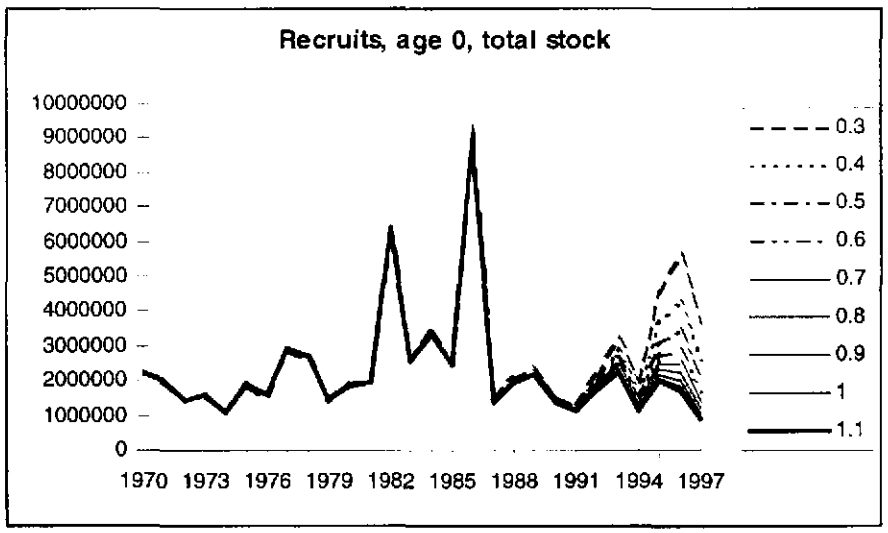


Figure 6.5.2 Recruitment at age 0 for autumn spawners, spring spawners and autumn spawners and spring spawners as one stock for selected values of terminal F in the separable analysis. Note the different scale of the spring spawners.

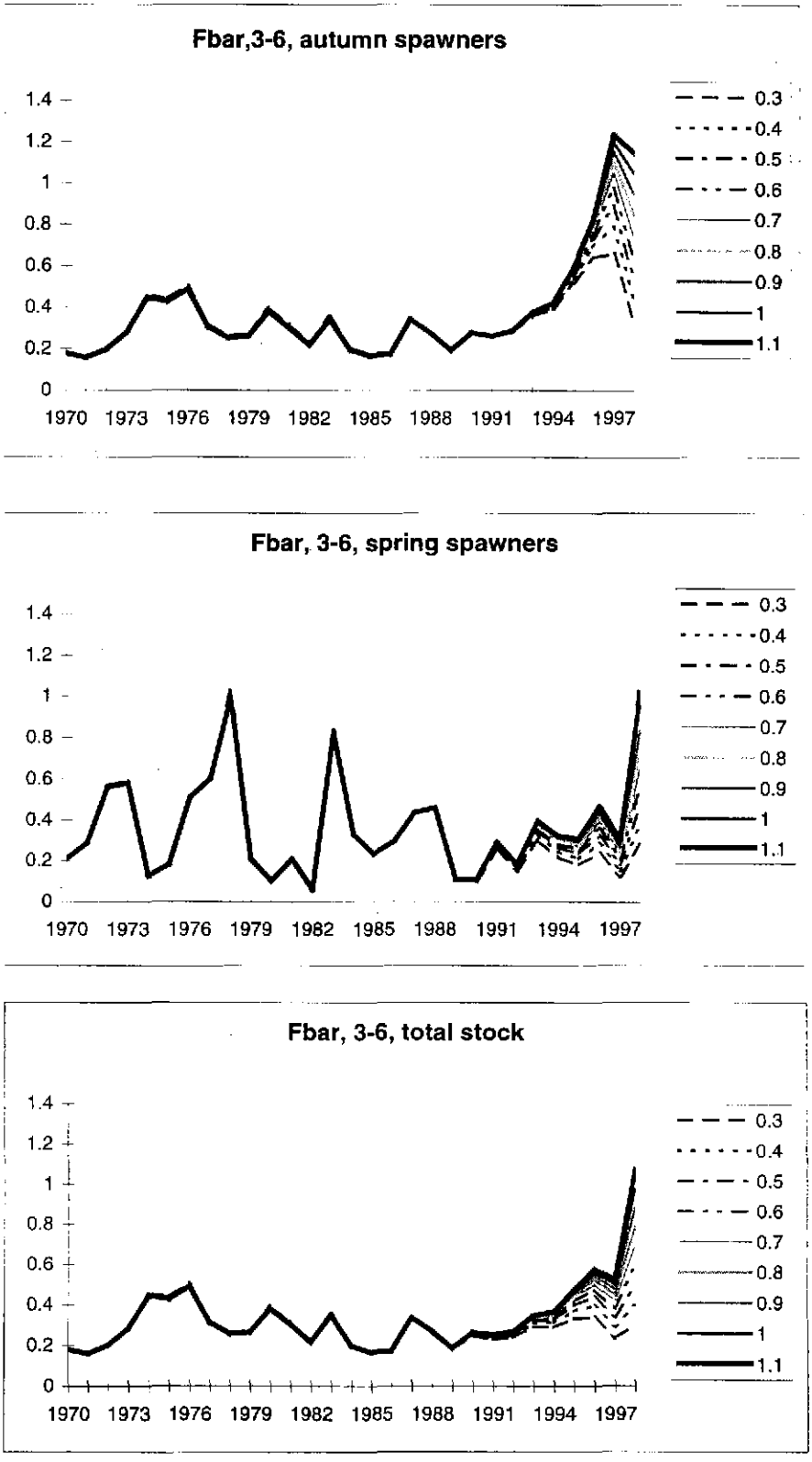


Figure 6.5.3 Fbar (aritmetric mean of F-values) age 3-6 for autumn spawners, spring spawners and autumn spawners and spring spawners as one stock for selected values of terminal F in the separable analysis.

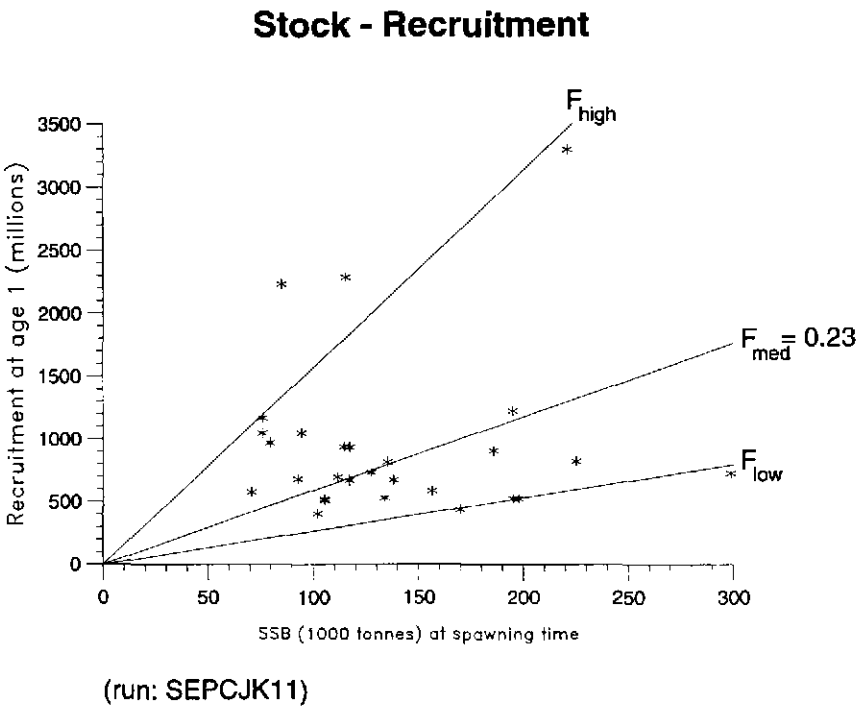


Figure. 6.6.1 Stock and recruitment for herring in VIaS and VIIbc

7 IRISH SEA HERRING (DIVISION VIIA, NORTH)

7.1 The Fishery

7.1.1 Advice and management applicable to 1998 and 1999

In 1997 the Working Group did not undertake an analytical assessment of this stock due to continued uncertainty about the fishing mortality and level of SSB. ACFM undertook an analysis using RCSEP1 (Cook *et al.* 1991) and concluded that the stock seems able to sustain the current fishing mortality. Consequently ACFM forecast a status quo fishing mortality which would give a catch of around 6,500 t in 1998. A TAC of 9,000 t was again adopted for 1998 and partitioned as 2,340 t to the Republic of Ireland and 6,660 t to the UK.

In 1998 the UK fishery opened in the third week in June. Closed areas for herring fishing in the Irish Sea along the east coast of Ireland and within 12 nautical miles of the west coast of Britain were maintained throughout the year. The traditional September, gillnet fishery on the Mourne herring, which has a derogation to fish within the Irish closed box, did not take place in 1998. The area to the east of the Isle of Man (encompassing the Douglas Bank spawning ground) was closed from 21 September to 31 December.

In 1998 the Working Group undertook an analytical assessment of the stock. However, due to the uncertainty of the assessment the shrinkage option in ICA was applied. The model estimate of the 1997 F was shrunk to the mean the years 1987 to 1997. Consequently ACFM recommended that F in 1999 should be reduced to $F_{pa} = 0.36$ to ensure that the SSB is maintained within the precautionary region. This corresponds to a catch of 4,900 t. A TAC of 6,600 t was adopted for 1999 and partitioned as 1,720 t to the Republic of Ireland and 4,880 t to the UK.

7.1.2 The fishery in 1998

The catches reported from each country, for the period 1985 to 1998 are given in Table 7.1.1 and from 1972 to 1998 in Figure 7.1.1. Reported landings for the Irish Sea amounted to 4,905 t of which 1,187 t were misreported from adjacent areas. The total catch of 3,718 t taken within Division VIIa(N) was below the TAC of 9,000 t as was the case in previous years. This conforms to the pattern set in 1993 when the Republic of Ireland ceased taking their quota from Division VIIa(N). However, in 1998 the UK fleet did not take its full quota, and there were no landings into the Isle of Man. The reduced catch was due to both the Manx kipper industry obtaining herrings from North Sea suppliers rather than the local Irish Sea suppliers and fleet changes within the Northern Ireland herring fishery itself. The number of vessels that specifically target herring present in the Irish Sea has fallen to its lowest level in 30 years. Unlike previous years, the majority of the catch was taken in the last quarter. In 1998, 32% of the total catch was taken in the 3rd quarter and the remainder in the 4 th quarter. The proportion of the catch caught by non-Northern Ireland boats (20%) was the largest for many years. There were no landings during the 1st and 2 nd quarters or from the Mourne gillnet fishery.

7.1.3 Quality of catch and biological data

There are still no estimates of discarding or slippage of herring in the Irish Sea fisheries. Working Group landing statistics are assumed to be accurate. Biological sampling in this fishery remains fairly high with approximately one sample per 160 t landed (Table 7.1.2). However, there were very few samples taken in the 4 th quarter when 64% of the catch was landed.

7.1.4 Catch in numbers

Catches in numbers at age are given in Table 7.1.3 for the years 1972 to 1998. The predominant year class in 1998 was the 2-ringers (1995 year class). The 1992 year class, which was numerically the most abundant year class in the 1995 catches was still abundant in the 1998 catches. The 1990 year class was also still abundant. The catch in numbers at length is given in Table 7.1.4 for 1988 to 1998. The distribution of lengths in 1998 was similar to that in the preceding years with very few fish over 30 cm compared with 1988 and 1989, during which the strong 1979 and 1980 year classes were abundant in the catches (see Table 7.1.3).

7.2 Mean length, weight, maturity and natural mortality at age

Mean lengths at age were calculated for the 3rd and 4 th quarters using the Northern Ireland and Isle of Man data and are given for the years 1985 to 1998 in Table 7.2.1. In general, mean lengths at age have remained fairly stable since 1988.

Mean weights at age in the catch are given in Table 7.2.2. Mean weights at age in 1998 were, in general, comparable to the mean weights in 1997. Mean weights at age in the third-quarter catches have been used as estimates of stock weights at spawning time.

The maturity ogive used since 1994 (ICES 1994a) was used again since there was no evidence to suggest a change: 0.08 for 1-ringers, 0.85 for 2-ringers and 1.00 for 3+-ringers.

As in previous years, natural mortality per year was assumed to be 1.0 on 1-ringers, 0.3 on 2-ringers, 0.2 on 3-ringers and 0.1 on all older age classes.

7.3 Research surveys

7.3.1 Acoustic surveys

The information on the time series of acoustic surveys in the Irish Sea is given in Table 7.3.1. Revisions have been made to the biomass estimates from the September 1995 survey.

An acoustic survey was undertaken over the central northern Irish Sea (Division VIIa(N)), centred on the spawning area for Manx herring between 8 th and 14 th September 1998 by the Department of Agriculture for Northern Ireland (DANI) as part of a time series that commenced in 1994. An intensive survey of the Douglas Bank spawning ground was carried out in darkness using transects spaced at one nautical mile intervals. Due to problems with the transducer over part of the survey additional transects were undertaken during the ground fish survey between the 5 th and 8 th October 1998. The survey is described in detail by Armstrong *et al.* (WD 1999a). The survey was carried out using a Simrad EK500 echosounder with a towed 38 and 120 kHz split-beam transducer. Targets were identified where possible by midwater trawling, and appropriate ALKs constructed from catch samples. The majority of adult herring (> 22 cm) were found to the east of the Isle of Man close to the traditional spawning area for this stock (Figure 7.3.1). The estimated SSB of herring in VIIa(N) was 7,760 t (Table 7.3.1). The age structure of herring from the acoustic survey is given in Table 7.3.2. The revised 1995 herring age structure is also given in this table. The estimated biomass of sprat was the second highest in the series, after 1995.

There are a number of observations on the acoustic surveys which are pertinent to the interpretation of these data. The strong 1985 year class was probably responsible for the large number of fish in the 8+ group in 1994. The number in the plus group has declined since 1994. The precision of the estimates of abundance for individual year classes is likely to be poor given the high CVs for the age-aggregated biomass estimates. The large estimate of 1-ringers in 1995 is not reflected in a corresponding ages in 1996 and 1997. This may reflect survey imprecision or the variable abundance of Celtic Sea juveniles in the Irish Sea. Given the broad 95% confidence intervals of the SSB estimates it is not possible to identify any significant increasing or decreasing trends in abundance of 1-ring and older herring over the period 1994–98. However, the SSB in 1998 was estimated with higher precision than in previous years, and the decline to a series low was observed off both the west and east coasts of the Isle of Man.

The fishing industry claims that there has been a change in the pattern of movement of Irish Sea adult herring in recent years, and substantial spawning aggregations were located off the Solway Firth in 1997 and 1998. This may reflect a diversion of spawning effort away from Douglas Bank. Acoustic survey effort was low to the north of the Isle of Man in 1998 and no herring spawning aggregations were recorded. However the larval survey in November 1998 found newly hatched larvae (see below) which supports the notion of a possible shift in spawning patterns.

7.3.2 Larvae surveys

Larvae surveys were undertaken by Northern Ireland (Douglas Bank, northern Irish Sea) and the Isle of Man (Douglas Bank, north-eastern Irish Sea). Poor weather conditions between September and November 1998 reduced the survey coverage considerably for the Douglas Bank (Dickey-Collas WD 1999, Nash *et al.* WD 1999a). The Isle of Man survey on 21st September 1998 had an extremely low abundance indicating that very little hatching had occurred at that time. From the DANI survey on the 20 th October to the Isle of Man survey on the 6 th November 1998 there was a steady increase in the abundance of larvae on Douglas Bank (Fig 7.3.2). The estimate of larvae production from the Douglas Bank November survey was low compared to 1997 (Table 7.3.3). However, this value should be treated with a certain degree of caution as the survey had poor coverage and it was later than in previous years. Hence it is likely to result in a considerable bias in the production estimate due to larval dispersal from the spawning grounds. There was good coverage of the north-eastern Irish Sea in November and December (Figure 7.3.3; Dickey-Collas WD 1999, Nash *et al.* WD 1999b). There was the predictable decline in abundance from the beginning of November to the beginning of December (Fig. 7.3.2). The DANI survey gave a lower estimate of larvae production than the previous year, as did the

Isle of Man survey (Table 7.3.3; Figure 7.3.4). The distribution of spawning dates, back-calculated from the length at capture, suggested that the majority of the larvae were spawned throughout October.

Once again, there were very few Mourne larvae caught in the Northern Irish survey (Dickey-Collas WD 1999).

In the DANI November survey there were substantial concentrations of small larvae in the vicinity of the Solway Firth (north of the traditional Manx spawning grounds) (Dickey-Collas WD 1999). In previous years concentrations of small herring larvae have been noted to the north of the Isle of Man which suggests that there may be a shift to other spawning grounds in the area. Similarly, in recent years concentrations of stage 6 fish have been noted on the Douglas Bank spawning grounds in November and the timing of hatch, based on the larvae production estimates from the north-eastern surveys, suggests a later spawning. This information indicates that the behaviour and ecology of herring in the Irish Sea are likely to be more variable than often assumed (Bowers, 1980).

7.3.3 Groundfish surveys of Area VIIa(N).

Groundfish surveys, carried out by Northern Ireland since 1991 in the Irish Sea, were used by the 1996 to 1998 Herring Assessment Working Groups to obtain indices for 0 and 1-ringer herring in the Irish Sea (ICES 1998a) (Table 7.4.1). These data indicate a strong 1992 year class (1-ringer in 1994) but the large 1990 year class 1-ringer in 1992), found in the catch at age data, was not apparent (Table 7.4.1). The 0-ringer (September), 1-ring (March, June and September) indices were averaged as a 1-ring recruitment index for the whole Irish Sea and for the eastern and western Irish Sea, with the values weighted by the inverse of the survey sample CVs (Figure. 7.3.2). The rationale for this was to reduce the noise generated by individual indices. The eastern and western indices were designed to highlight and possibly reduce potential problems associated with juvenile Celtic Sea fish in the Irish Sea (Armstrong *et al.* WD 1999b).

It should be noted that the indices were reworked for the 1999 Working Group. The main differences between 1998 and 1999 are in the perception of a higher index for the 1998 year class compared with the data presented in 1998 (ICES 1998a). This index shows the strong 1992 year class and suggests relatively strong 1995 and 1996 year classes (Figure 7.3.5).

The reliability of trawl indices of herring abundance in the Irish Sea will be affected by mixing of Irish Sea and Celtic Sea juveniles, which co-occur, particularly in the western region. There are similarities in the recruitment patterns in both the Irish and Celtic Sea populations (Armstrong *et al.* 1999b WD) with correlations between the ICA estimated recruitment for the two stocks. By removing the 1990 year class from comparisons, there is an improvement in the correlation between the 1-ringer index and the ICA estimates. However, there is a very poor correlation between the eastern Irish Sea 1-ringer index and the western Irish Sea index (Armstrong *et al.* 1999b WD). It is suggested that the eastern Irish Sea index may in fact be a better indicator of variation in recruitment to the Manx spawning stock as it is probably less influenced by the presence of Celtic Sea herring (Armstrong *et al.* 1999b WD).

There is a little evidence, although unquantifed, that some of the herring in the Irish Sea are now spawning on Douglas Bank in late winter (Isle of Man ground fish surveys). The size of this spawning population will be investigated in 2000 with larval surveys from February to May and an analysis of the size distribution of eastern Irish Sea fish aged 0.

7.4 Data exploration and preliminary modelling

In 1998 the Working Group explored the possibility of undertaking an analytical assessment, investigated the various tuning indices available, concluded that there was uncertainty in the assessment and opted for the shrinkage option in ICA (ICES 1998a). The shrinkage option had been used previously in 1996, where the Douglas Bank larvae series, acoustic surveys and the June and September Ground Fish Survey 1-ringer indices were used. The model estimate of F for 1997 was shrunk to the mean of 1987 to 1997. Since there was no objective way of choosing between CVs at 0.0 and 0.1, the run with a minimum CV of 0.0 was chosen for making short-term predictions. This assessment gave a mean $F_{(2-6)}$ for 1997 as 0.403 and an SSB of 8,200 t. The tuning indices used were the Northern Irish NE Irish Sea larvae production estimates, minus 1996 (NINEL) and the mean groundfish 1-ringer index (GFS-mean).

The Division VIIa(N) acoustic survey estimates were not considered as absolute because of discrepancies between acoustic estimates and tuned SSB estimates seen in other stocks. Fits within ICA were found in 1998 with all indices with DBL giving a very low mean F(2–6) = < < 0.01 and ACAGE, NINEL and AC_VIIa(N) giving mean Fs of > 1 (ICES 1998a). There was some doubt about the 1996 data for the NINEL series (the value was very low due to the spawning period being 3 weeks later than expected) so the analysis was rerun without this index value. This made very little change to the perceived mean F in 1997 although the confidence limits were was greatly reduced. Precision was generally poor. In an attempt to explore the performance of these tuning indices the NINEL index was combined with

GFS-mean. The analysis with this combination of indices gave similar results in perceived F(97) to that obtained using the NINEL index on its own.

This year new data were added to the Douglas Bank larvae series (DBL), Northern Irish larvae series (NINEL) and the Northern Irish acoustic survey with adjusted 1995 values (AC-VIIa(N), and ACAGE) for SSB tuning files. The 1-ringer recruitment index (GFS-mean) for the whole Irish was reworked and data for 1999 added, as was the eastern Irish Sea 1-ringer index (GFS-east; Figure 7.4.1). This year, the survey indices were used to initiate an analytical assessment using an integrated catch-at-age analysis (ICA) including a separable constraint (Deriso *et al.* 1985). The following short survey series were available for inclusion in an assessment using the ICA package:

1. Larval production estimates from Douglas Bank surveys to provide an SSB index: 1989 - 1998 (**DBL**)
2. Larval production estimates from the Northern Ireland surveys in the north-east Irish Sea: 1993 - 1998 (**NINEL**)
3. Age-aggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 - 1998 (**AC_VIIa(N)**)
4. Age-disaggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 - 1998 (**ACAGE**)
5. Mean catch of juvenile herring (inverse weighted mean of catches of 0 and 1 ring herring in September and March from all strata in the whole Irish Sea area) as a 1-ringer index (1992 - 1999) (**GFS-mean**)
6. Mean catch of juvenile herring (inverse weighted mean of catches of 0 and 1 ring herring in September and March from all strata in the eastern Irish Sea only) as a 1-ringer index (1992 - 1999) (**GFS-east**)
7. Age-aggregated acoustic estimates of Manx herring spawning aggregations in 1989, 1990 and 1994 (**AC_DB**)

NB: the index AC_DB was not used in 1999.

The different indices are given in Tables 7.4.1 and 7.3.2. The relative concordance between the various groundfish 1-ringer indices is given in Figure 7.4.1. Overall, all three SSB indices ((AC_VIIa(N), DBL and NINEL suggest a decline in the North Irish Sea SSB (Figure 7.4.1). There is a concordance between the Douglas Bank and Northern Irish north-eastern larvae surveys (Figure 7.4.2).

The ICA model was fitted using each series (1–6). The following input values were used:

- Separable constraint over last 6 years (weighting = 1.0 for each year)
- Reference age = 4
- Constant selection pattern model
- Selectivity on oldest age = 1.0
- First age for calculation of mean F = 2
- Last age for calculation of mean F = 6
- Weighting on 1-ringers = 0.1; all other age classes = 1.0
- Weighting for all years = 1.0
- All indices treated as linear
- No S/R relationship fitted
- Lowest and highest feasible F = 0.05 and 2.0
- All survey weights fitted by hand i.e., 1.0
- Correlated errors assumed i.e., = 1.0
- No shrinkage applied

Once again the Division VIIa(N) acoustic survey estimates were not considered as absolute because of discrepancies between acoustic estimates and tuned SSB estimates seen in other stocks. Solutions were found with all indices with GFS-mean giving a very low reference F = < < 0.01, DBL giving a low reference F = 0.17, the GFS-east also gave a relatively low reference F = 0.36 and ACAGE, NINEL and AC_VIIa(N) giving reference Fs of between 0.67 and 0.81 (Figure 7.4.2). In 1998 there was some doubt about the 1996 data for the NINEL series (the value was very low due to the spawning period being 3 weeks later than expected) so the analysis was rerun without this index value. This made very little change to the perceived reference F in 1998. In general, the 95% confidence intervals of F were much reduced compared to the previous year.

In view of the conflicting signals from the available tuning data and the variability in perceptions of mean $F_{(2-6)}$ it was decided to continue with an ICA run using only the GFS-east 1-ringer indices and to use the shrinkage option. GFS-east was used instead of GFS-mean as the eastern index is more indicative of the 1-ringers in the Irish Sea and it had a lower minimum in the sum of squares than the GFS-mean. The decision to not use the NINEL series was due to it having a very different the SSQ minimum to GFS-east (twice as large and very shallow) and its fit to ICA being poor compared

to the assessment in 1998. Using the single index, GFS-east, gave a perception of the stock in 1997 very similar to the perception in the assessment in 1998 (ICES 1998a). The shrinkage option was used in the 1996 and 1998 assessments when faced with a similar degree of uncertainty in the perception of the SSB in Division VIIa(N). This option is consistent with the underlying principals used by the 1998 Working Group and the method used here is consistent with the principles applied to all other herring stocks assessed by this Working Group.

7.5 Stock assessment

The structural model used for the baseline assessment, based on the results given in Section 7.4, is given as:

$$\sum_{a,y}(\ln(C_{a,y}) - \ln(C'_{a,y}))^2 + \sum_{1,y}(\ln(Q_{GFS-east}N_{1,y}) - \ln(GFS-east_{1,y}))^2$$

where:

a,y	age and year subscripts
C	Catch in number at age and year
C'	Catch in number at age and year predicted by a separable fishing model
GFS-east	Ground Fish Survey estimates of 1-ringers (eastern Irish Sea only)
N	Population abundance in the structural model
Q	Coefficients of proportionality for survey indices

The results of the baseline model fit are shown in Figures 7.5.1–7.5.4 and the run log is given in Table 7.5.1. The SSQ surface for the index shows a minimum at an intermediary level of fishing mortality. The estimate for $F_{(2-6)}$ for 1998 was 0.42 (Table 7.5.2) with a corresponding SSB estimate of approximately 6,904 t. This assessment shows estimated fishing mortality to be similar to the shrunk Fs from the 1998 assessment. SSB was marginally higher than the assessment last year with the exception of the estimate for 1997.

In 1998 the model estimate of the 1997 F was shrunk to the mean of 1987 to 1997. ACFM requested that if the shrinkage option was used again then the time span for shrinkage should be explored. This year shrinkage over 3, 5, 10 and 15 years was undertaken using minima shrinkage CVs of 0.5 and 0.0. There was little effect on estimates of $F_{(2-6)}$ or SSB using combinations of CV and numbers of years for shrinkage (Table 7.5.3).

Since there was no objective way of choosing between the various CVs and time periods for shrinkage and the differences were very small, the option used in 1998, of 10 years and a CV of 0, was chosen for making short-term predictions. This assessment gave a mean $F_{(2-6)}$ for 1998 as 0.347 and an SSB of 7,610 t. This estimate gives a slightly higher F_{2-6} and lower SSB for 1997 than was given by the 1998 Working Group. The population estimates, fishing mortalities and stock summary table for the shrunk assessment are given in Table 7.5.4. The standard fish stock summary plots are shown in Figure 7.5.5 and the stock recruitment plot with F_{low} (0.16), F_{med} (0.35) and F_{high} (0.59) shown in Figure 7.5.6.

7.6 Stock and Catch Projection

Short-term predictions were carried out using the shrunk ICA estimates of population numbers and fishing mortalities (Section 7.5). These projections are for illustrative purposes only as the Working Group is very unsure of the actual status of this stock. The numbers of 1-ringers in 1999 was taken from the ICA output as this reflected the perception of recruitment for this year from the 1-ringer tuning index (GFS-east) and the ages in the acoustic surveys (Table 7.4.1, see also Table 7.4.1). The numbers of 1-ringers in 1999 and 2000 were assumed to be a geometric mean of the recruitment over the period 1983–1998 (Table 7.6.1). Mean weights in the catch and in the stock were taken as a mean for the years 1996–1998. The shrunk ICA estimates of F at age in 1998 were used for the exploitation pattern. Predictions of stock and yield were made assuming; TAC constraint of either the complete TAC (6,600 t) being taken up or UK landings reaching quota (4,900 t) in 1999, and $F_{status\ quo}$ in 1998. The full TAC option is necessary as there is a possibility that it could be taken. Predictions for 2000 and 2001 were made for a range of F-multipliers.

An $F_{status\ quo}$ in 1999 would result in a catch of 4,022 t (Table 7.6.2). The UK catch of 4,880 t in 1999 suggests an F of 0.44 which is an increase from F(1998). There would be no change in SSB. The full TAC constraint (6,600 t) would result in an F(1999) = 0.65 with a concomitant increase in F and small decline in SSB. An $F_{status\ quo}$ for the years 1999 to 2000 gives a relatively stable low SSB for all scenarios (Table 7.6.3). Details of stock structure in 1999–2001, assuming

a catch of 4,880 t in 1999, are given in Table 7.6.4. *Status quo* catch in 2000 is between 3,500 and 4,200 t depending on the catch in 1999.

7.7 Medium-term predictions of stock size

The present assessment is based on the assumption of stability in the stock. Therefore, the Working Group decided that there was no real basis for undertaking a meaningful medium term projection of stock size. The current state of herring recruitment to VIIaN is unclear, considering the imprecision in the assessments **and the variable mixing of Celtic Sea and western Irish Sea juveniles**. Also the historical assessments of recruitment have incorporated both Manx and Mourne components and the contribution of the Mourne component is now thought to be negligible.

7.8 Management considerations

7.8.1 Precision of the assessment

The current time-series of survey data are very short and, as seen here, prone to providing variable perceptions of stock development. The analysis presented here is consistent with the ICA method used by this Working Group. The current SSB is lower than perceived by the Working Group in 1998. There have probably been changes in this stock since the early 1990s with the severe reduction in the Mourne component of VIIa(N). The consequence of this is that the SSB in VIIa(N) may be lower than when both components are present. This change in stock dynamics and the variability in the tuning data mean that this assessment should be treated with caution. There is also the suggestion of a unquantified spring spawning component to this stock (see Section 7.3.3). There is little doubt, however, that the autumn spawning SSB has declined over recent years and the ecology and behaviour of the stock is in a state of flux. It is likely that an analytical assessment will be possible in the future with longer time-series from this area.

Although there is considerable between year variation in SSB indices, the series suggest a decline in SSB over the last few years. The 1-ringer recruit indices do not suggest any recent strong year classes. Therefore, maintaining catch levels, in the short-term, of approximately 3,500–4,500 t should not be detrimental to the stock. Because of the uncertainty associated with the perceived size of the stock, it would be prudent to keep catches below 4,500 tonnes in the short term.

7.8.2 Spawning and Juvenile Fishing Area Closures

The arrangement of closed boxes in Division VIIa(N) prior to 1999 are discussed in detail in ICES (ICES 1996a). The closed areas consist of: all year juvenile closures along the east coast of Ireland, and the west coast of Scotland, England and Wales; spawning closures along the east coast of the Isle of Man, and along the east coast of Ireland.

There will be a change in the closure area and time for the Douglas Bank spawning ground from 21st September- 31st December to 21st September - 15 th November for 1999. In view of the uncertainties in the size of the stock in Division VIIa(N) **the Working Group recommends that any alterations to the present closures are considered carefully, in the context of this report, to ensure protection for all components of this stock.**

Table 7.1.1. Irish Sea HERRING (Division VIIa(N)). Catch in tonnes by country, 1985-1998. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1985	1986	1987	1988	1989	1990	1991
Ireland	1,000	1,640	1,200	2,579	1,430	1,699	80
UK	4,077	4,376	3,290	7,593	3,532	4,613	4,318
Unallocated	4,110	1,424	1,333	-	-	-	-
Total	9,187	7,440	5,823	10,172	4,962	6,312	4,398

Country	1992	1993	1994	1995	1996	1997	1998
Ireland	406	0	0	0	100	0	0
UK	4,864	4,408	4,828	5,076	5,180	6,651	4,905
Unallocated	-	-	-	-	22	-	-1,187
Total	5,270	4,408	4,828	5,076	5,302	6,651	3,718

Table 7.1.2 Irish Sea HERRING. Sampling intensity of commercial landings for Division VIIa (N) in 1998.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
1	Ireland	0	-	-	-	-
	UK (N. Ireland)	0	-	-	-	-
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
2	Ireland	0	-	-	-	-
	UK (N. Ireland)	0	-	-	-	-
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
3	Ireland	0	-	-	-	-
	UK (N. Ireland)	1153	27	2530	1350	No
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	23	0	0	0	No
	UK (England & Wales)	0	-	-	-	-
4	Ireland	0	2	150	50	No
	UK (N. Ireland)	2978	2	449	100	No
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	493	0	0	0	No
	UK (England & Wales)	257	0	0	0	No

Table 7.1.3 Herring in the North Irish Sea (Manx plus Mourne VIIa(N)). Catch in numbers (thousands) by year.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1972	40640	46660	26950	13180	13750	6760	2660	1670
1973	42150	32740	38240	11490	6920	5070	2590	2600
1974	43250	109550	39750	24510	10650	4990	5150	1630
1975	33330	48240	39410	10840	7870	4210	2090	1640
1976	34740	56160	20780	15220	4580	2810	2420	1270
1977	30280	39040	22690	6750	4520	1460	910	1120
1978	15540	36950	13410	6780	1740	1340	670	350
1979	11770	38270	23490	4250	2200	1050	400	290
1980	5840	25760	19510	8520	1980	910	360	230
1981	5050	15790	3200	2790	2300	330	290	240
1982	5100	16030	5670	2150	330	1110	140	380
1983	1305	12162	5598	2820	445	484	255	59
1984	1168	8424	7237	3841	2221	380	229	479
1985	2429	10050	17336	13287	7206	2651	667	724
1986	4491	15266	7462	8550	4528	3198	1464	877
1987	2225	12981	6146	2998	4180	2777	2328	1671
1988	2607	21250	13343	7159	4610	5084	3232	4213
1989	1156	6385	12039	4708	1876	1255	1559	1956
1990	2313	12835	5726	9697	3598	1661	1042	1615
1991	1999	9754	6743	2833	5068	1493	719	815
1992	12145	6885	6744	6690	3256	5122	1036	392
1993	646	14636	3008	3017	2903	1606	2181	848
1994	1970	7002	12165	1826	2566	2104	1278	1991
1995	3204	21330	3391	5269	1199	1154	926	1452
1996	5335	17529	9761	1160	3603	780	961	1364
1997	9551	21387	7562	7341	1641	2281	840	1432
1998	2326	9004	2937	3373	5059	781	1553	342

Table 7.1.4 HERRING in Division VIIa (North). Catch at length for 1988-1998. Numbers of fish in thousands

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
14	1										
	1										
15	1				95						
	10				169						
16	13		6		343			21	21	17	
	16		6	2	275			55	51	94	
17	29		50	1	779		84	139	127	281	20
	44	24	7	4	1,106		59	148	200	525	23
18	46	44	224	31	1,263		69	300	173	1,022	93
	85	43	165	56	1,662		89	280	415	1,066	156
19	247	116	656	168	1,767	39	226	310	554	1,720	240
	306	214	318	174	1,189	75	241	305	652	1,263	210
20	385	226	791	454	1,268	75	253	326	749	1,366	324
	265	244	472	341	705	57	270	404	867	1,029	225
21	482	320	735	469	705	130	400	468	886	1,510	396
	530	401	447	296	597	263	308	782	1,258	1,192	416
22	763	453	935	438	664	610	700	1,509	1,530	2,607	1,026
	1,205	497	581	782	927	1,224	785	2,541	2,190	2,482	833
23	2,101	612	2,400	1,790	1,653	2,016	1,035	4,198	2,362	3,508	1,890
	3,573	814	1,908	1,974	1,156	2,368	1,473	4,547	2,917	3,902	1,547
24	5,046	1,183	3,474	2,842	1,575	2,895	2,126	4,416	3,649	4,714	2,801
	5,447	1,656	2,818	2,311	2,412	2,616	2,564	3,391	4,077	4,138	2,099
25	5,276	2,206	4,803	2,734	2,792	2,207	3,315	3,100	4,015	5,031	1,990
	4,634	2,720	3,688	2,596	3,268	2,198	3,382	2,358	3,668	3,971	2,120
26	4,082	3,555	4,845	3,278	3,865	2,216	3,480	2,334	2,480	3,871	2,361
	4,570	3,293	3,015	2,862	3,908	2,176	2,617	1,807	2,177	2,455	2,002
27	4,689	2,847	3,014	2,412	3,389	2,299	2,391	1,622	1,949	1,711	2,268
	4,124	2,018	1,134	1,449	2,203	2,047	1,777	990	1,267	1,131	1,324
28	3,406	1,947	993	922	1,440	1,538	1,294	834	906	638	936
	2,916	1,586	582	423	569	944	900	123	564	440	129
29	2,659	1,268	302	293	278	473	417	248	210	280	84
	1,740	997	144	129	96	160	165	56	79	59	70
30	1,335	801	146	82	70	83	9	40	32	8	64
	685	557	57	36	36	15	27	5	0	5	2
31	563	238	54	12	2	4		1	2		
	144	128	31	3							
32	80	57	29								
	7	7									
33	2	5									
	1	6									
34		0									
		5									

Table 7.2.1 HERRING in Division VIIa (North). Mean length at age.

Year	Lengths at age (cm)							
	Age (rings)							
	1	2	3	4	5	6	7	8
1985	22.1	24.3	26.1	27.6	28.3	28.6	29.5	30.1
1986	19.7	24.3	25.8	26.9	28.0	28.8	28.8	29.8
1987	20.0	24.1	26.3	27.3	28.0	29.2	29.4	30.1
1988	20.2	23.5	25.7	26.3	27.2	27.7	28.7	29.6
1989	20.9	23.8	25.8	26.8	27.8	28.2	28.0	29.5
1990	20.1	24.2	25.6	26.2	27.7	28.3	28.3	29.0
1991	20.5	23.8	25.4	26.1	26.8	27.3	27.7	28.7
1992	19.0	23.7	25.3	26.2	26.7	27.2	27.9	29.4
1993	21.6	24.1	25.9	26.7	27.2	27.6	28.0	28.7
1994	20.1	23.9	25.5	26.5	27.0	27.4	27.9	28.4
1995	20.4	23.6	25.2	26.3	26.8	27.0	27.6	28.3
1996	19.8	23.5	25.3	26.0	26.6	27.6	27.6	28.2
1997	19.6	23.6	25.1	26.0	26.5	27.1	27.7	28.2
1998	20.8	23.8	25.2	26.1	27.0	26.8	27.2	28.7

Table 7.2.2 HERRING in Division VIIa (North). Mean weights at age.

Year	Weights at age (g)							
	Age (rings)							
	1	2	3	4	5	6	7	8
1985	87	125	157	186	202	209	222	258
1986	68	143	167	188	215	229	239	254
1987	58	130	160	175	194	210	218	229
1988	70	124	160	170	180	198	212	232
1989	81	128	155	174	184	195	205	218
1990	77	135	163	175	188	196	207	217
1991	70	121	153	167	180	189	195	214
1992	61	111	136	151	159	171	179	191
1993	88	126	157	171	183	191	198	214
1994	73	126	154	174	181	190	203	214
1995	72	120	147	168	180	185	197	212
1996	67	116	148	162	177	199	200	214
1997	64	118	146	165	176	188	204	216
1998	80	123	148	163	181	177	188	222

Table 7.3.1 Herring: Summary of acoustic survey information for Division VIIa(N) for the period 1989-1998. Small clupeoids include sprat and 0-ring herring unless otherwise stated. CVs are approximate. Biomass in t. All surveys carried out at 38kHz except December 1996, which was at 120kHz.

Year	Area	Dates	herring biomass (1+ years)	CV	herring biomass (SSB)	CV	small clupeoids biomass	CV
1989	Douglas Bank	25-26 Sept			18000	-	-	-
1990	Douglas Bank	26-27 Sept			26,600	-	-	-
1991	Western Irish Sea	26 July - 8 Aug	12,760	0.23			66,000[1]	0.20
1992	Western Irish Sea + IOM east coast	20 - 31 July	17,490	0.19			43,200	0.25
1994	Area VIIa(N)	28 Aug - 8 Sep	31,400	0.36	26,190	-	68,600	0.10
	Douglas Bank	22-26 Sept			28200	-	-	-
1995	Area VIIa(N)	11-22 Sept	38,400	0.29	19,900	-	348,600	0.13
	Douglas Bank	10-11 Oct		-	9,840	-	-	-
	Douglas Bank	23-24 Oct			1,750	0.51	-	-
1996	Area VIIa(N)	2-12 Sept	24,500	0.24	23,390	0.25	49,120	0.13
	Eastern Irish Sea (closed box)	9-12 Dec	12,800	0.49	11,880	0.49	6,810	0.13
1997	Area VIIa(N)-reduced	8-12 Sept	20,100	0.28	11,300	0.28	46,600	0.20
1998	Area VIIa(N)	8-14 Sept	21,200	0.15	7,760	0.18	228,000	0.11

1 sprat only

Table 7.3.2 Age structure of herring in Division VIIa(N) from the Northern Ireland Acoustic surveys in September.

Age (rings)	1994	1995	1996	1997	1998
1	66.8	319.1	11.3	134.1	110.4
2	68.3	82.3	42.4	50.0	27.3
3	73.5	11.9	67.5	14.8	8.1
4	11.9	29.2	9.0	11.0	9.3
5	9.3	4.6	26.5	7.8	6.5
6	7.6	3.5	4.2	4.6	1.8
7	3.9	4.9	5.9	0.6	2.3
8+	10.1	6.9	5.8	1.9	0.8

Table 7.3.3 Irish Sea HERRING larval production (10^{11}) indices for the Manx component of Division VIIa(N). Brackets denote one standard error.

Year	Douglas Bank		North East Irish Sea	
	Isle of Man	Northern Ireland	Isle of Man	Northern Ireland
1989	3.39			
1990	1.92			
1991	1.56			
1992	15.64		128.86	
1993	4.81		1.10	38.3 (18.4)
1994	7.30		12.50	71.2 (8.4)
1995	1.58		-[1]	15.1 (9.3)
1996	-[1]		0.30	4.7 (1.4)
1997	5.59	8.46 (1.6)	35.90	29.1 (3.2)
1998	2.27	-[1]	3.5	5.8 (5.9)

[1]No assessment

Table 7.4.1 Tuning indices used for the Irish Sea (VIIa(N)) herring assessment. Values and approximate CVs are given. na = not available. GFS-mean = Weighted mean of groundfish survey, 0 and 1 group abundance for the whole Irish Sea; GFS-mean E = Weighted mean of groundfish survey, 0 and 1 group abundance for the eastern Irish Sea; SSBA = Spawning stock biomass by acoustic techniques (AC_DB = Douglas Bank acoustic surveys covering only the spawning stock, AC_VIIa(N) = Irish Sea acoustic surveys covering 2+ ringers; , AC_VIIa(N)1+ = Irish Sea acoustic surveys covering 1+ ringers); DBL = larvae production on Douglas Bank. (October); NINEL=larvae production in the north-eastern Irish Sea (November).

Year	GFS-mean[1]	GFS-mean E[1]	DBL[2]	NINEL[2]	AC_DB[3]	AC_VIIa(N)[4]	AC_VIIa(N)1+[5]
1989			3.39 (0.49)		18000 (na)	-	
1990			1.92 (0.24)		26000 (na)	-	
1991			1.56 (0.22)		-	-	12760
1992	25	156	15.64 (0.55)		-	-	17490
1993	82	100	4.81 (0.18)	38.3 (0.48)	-	-	-
1994	182	198	7.30 (0.58)	71.2 (0.12)	28200 (na)	26190 (na)	31400
1995	77	30	1.58 (0.42)	15.1 (0.62)	-	19900 (na)	38400
1996	31	65	-	4.7* (0.30)	-	23390 (0.25)	24500
1997	131	102	5.59 (-)	29.1 (0.11)	-	11300 (0.28)	20100
1998	134	109	2.27	5.8	-	7760	21200
1999	171	8	-	-	-	-	-

1. Mean of numbers per 3nm trawl from juveniles aged 0 in September and aged 1 in March and the following September. Weighted by the inverse of the CV.
2. Numbers of larvae at 6mm x 10^{-11}
3. Biomass of spawning aggregation, tonnes.
4. Biomass of SSB, tonnes.
5. Biomass of 1+

Table 7.5.1 Herring in Division VIIa(N).

```
                    Integrated Catch at Age Analysis
                    --------------------------------

                            Version 1.4 w

                          K.R.Patterson
                     Fisheries Research Services
                          Marine Laboratory
                              Aberdeen

                            15 April 1998

/users/fish/ifad/ifapwork/hawg/her_nirs/CANUM.I24
/users/fish/ifad/ifapwork/hawg/her_nirs/WECA.I24
 Stock weights in 1999  used for the year 1998
/users/fish/ifad/ifapwork/hawg/her_nirs/WEST.I24
 Natural mortality in 1999  used for the year 1998
/users/fish/ifad/ifapwork/hawg/her_nirs/NATMOR.I24
 Maturity ogive in 1999  used for the year 1998
/users/fish/ifad/ifapwork/hawg/her_nirs/MATPROP.I24
No indices of spawning biomass to be used.
 No of years for separable constraint ?  --> 5' '6
 Reference age for separable constraint ?  --> 4
 Constant selection pattern model (Y/N) ?  --> y
 S to be fixed on last age ?  --> 1
 First age for calculation of reference F ?  --> 2
 Last age for calculation of reference F ?  --> 6
 Use default weighting (Y/N) ?  --> n
Enter relative weights at age
 Weight for age 1  --> .1
 Weight for age 2  --> 1
 Weight for age 3  --> 1
 Weight for age 4  --> 1
 Weight for age 5  --> 1
 Weight for age 6  --> 1
 Weight for age 7  --> 1
 Weight for age 8  --> 1
Enter relative weights by year
 Weight for year 1993  --> 1
 Weight for year 1994  --> 1
 Weight for year 1995  --> 1
 Weight for year 1996  --> 1
 Weight for year 1997  --> 1
 Weight for year 1998  --> 1
Enter new weights for specified years and ages if needed

 Enter year, age, new weight or -1,-1,-1 to end.  --> -1 -1 -1
  Is the last age of FLT07: Mean eastern age 1 (Catch: Thousa a plus-group (Y --> n
You must choose a catchability model for each index.

Models:   A  Absolute:  Index = Abundance . e
          L  Linear:    Index = Q. Abundance . e
          P  Power:     Index = Q. Abundance^ K .e

   where Q and K are parameters to be estimated, and
   e is a lognormally-distributed error.

 Model for FLT07: Mean eastern age 1 (Catch: Thousa  is to be A/L/P ?  --> l
 Fit a stock-recruit relationship (Y/N) ?  --> n
 Enter lowest feasible F  --> 0.05
 Enter highest feasible F  --> 2
Mapping the F-dimension of the SSQ surface
```

F	SSQ
.05	4.2274416579
.15	2.7347227950
.26	2.5838820756
.36	2.7015834200
.46	2.9094688844
.56	3.1526544496
.67	3.4085368884
.77	3.6665613798
.87	3.9215540054
.97	4.1709846248
1.08	4.4136940739
1.18	4.6492555204
1.28	4.8776372301

Table 7.5.1 (cont.)

```
    1.38          5.0990181021
    1.49          5.3136843216
    1.59          5.5219706524
    1.69          5.7242271464
    1.79          5.9207997622

    1.90          6.1120209165
    2.00          6.2982039144
Lowest SSQ is for F =      .241
---------------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 8
Year range in the analysis : 1972  . . . 1998
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 24
Number of observations : 49

Conventional single selection vector model to be fitted.

---------------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?  --> m
 Enter weight for FLT07: Mean eastern age 1 (Catch: Thousa  at age 1  --> 1
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for FLT07: Mean eastern age 1 (Catch: Thousa  --> 1
 Do you want to shrink the final fishing mortality (Y/N) ?  --> y
 Enter the no. of years to shrink to  --> 10
 Enter the minimum c.v. of the mean  --> 0
Seeking solution. Please wait.

Aged index weights
FLT07: Mean eastern age 1 (Catch: Thousa
 Age   :       1
 Wts :     1.000
 SSQ --- >  3.03570146404855
 SSQ --- >  3.0370162009138
 Computing covariance matrix. Please wait
F in 1998  at age 4  is  .358770  in iteration 1
 Detailed, Normal or Summary output (D/N/S)  --> n
 Output page width in characters (e.g. 80..132) ?  --> 132
Shrinking F to mean ...

 Shrunk VPA written to file ICA_SHR.I24

 Estimate historical assessment uncertainty ?  --> n
Succesful exit from ICA
```

Table 7.5.2. Herring in VIIa(N): Results of baseline assessment

Output Generated by ICA Version 1.4 — Herring N.Irish Sea (run: ICARDN24/I24)

Catch in Number x 10 ^ 6

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	40.64	42.15	43.25	33.33	34.74	30.28	15.54	11.77	5.84	5.05	5.10	1.31	1.17	2.43	4.49
2	46.66	32.74	109.55	48.24	56.16	39.04	36.95	38.27	25.76	15.79	16.03	12.16	8.42	10.05	15.27
3	26.95	38.24	39.75	39.41	20.78	22.69	13.41	23.49	19.51	3.20	5.67	5.60	7.24	17.34	7.46
4	13.18	11.49	24.51	10.84	15.22	6.75	6.78	4.25	8.52	2.79	2.15	2.82	3.84	13.29	8.55
5	13.75	6.92	10.65	7.87	4.58	4.52	1.74	2.20	1.98	2.30	.33	.45	2.22	7.21	4.53
6	6.76	5.07	4.99	4.21	2.81	1.46	1.34	1.05	.91	.33	1.11	.48	.38	2.65	3.20
7	2.66	2.59	5.15	2.09	2.42	.91	.67	.40	.36	.29	.14	.26	.23	.67	1.46
8	1.67	2.60	1.63	1.64	1.27	1.12	.35	.29	.23	.24	.38	.06	.48	.72	.88

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	2.23	2.61	1.16	2.31	2.00	12.15	.65	1.97	3.20	5.34	9.55	2.33
2	12.98	21.25	6.39	12.84	9.75	6.89	14.64	7.00	21.33	17.53	21.39	9.00
3	6.15	13.34	12.04	5.73	6.74	6.74	3.01	12.16	3.39	9.76	7.56	2.94
4	3.00	7.16	4.71	9.70	2.83	6.69	3.02	1.83	5.27	1.16	7.34	3.37
5	4.18	4.61	1.88	3.60	5.07	3.26	2.90	2.57	1.20	3.60	1.64	5.06
6	2.78	5.08	1.25	1.66	1.49	5.12	1.61	2.10	1.15	.78	2.28	.78
7	2.33	3.23	1.56	1.04	.72	1.04	2.18	1.28	.93	.96	.84	1.55
8	1.67	4.21	1.96	1.62	.81	.39	.85	1.99	1.45	1.36	1.43	.34

Weights at age in the catches (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07600	.08700	.06800
2	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.14200	.12500	.14300
3	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.18700	.15700	.16700
4	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21300	.18600	.18800
5	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.22100	.20200	.21500
6	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.24300	.20900	.22800
7	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.24000	.22200	.23900
8	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27300	.25800	.25400

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	.05800	.07000	.08100	.09600	.07300	.06200	.08900	.07000	.07500	.06700	.06400	.08000
2	.13000	.12400	.12800	.14000	.12300	.11400	.12700	.12300	.12100	.11600	.11800	.12300
3	.16000	.16000	.15500	.16600	.15500	.14000	.15700	.15300	.14600	.14800	.14600	.14800
4	.17500	.17000	.17400	.17500	.17100	.15500	.17100	.17000	.16400	.16200	.16500	.16300
5	.19400	.18000	.18400	.18700	.18100	.16500	.18200	.18000	.17600	.17700	.17600	.18100
6	.21000	.19800	.19500	.19500	.19000	.17400	.19100	.18900	.18100	.19900	.18800	.17700
7	.21800	.21200	.20500	.20700	.19800	.18100	.19800	.20200	.19300	.20000	.20400	.18800
8	.22900	.23200	.21800	.21800	.21700	.19700	.21200	.21200	.20700	.21400	.21600	.22200

Table 7.5.2. (cont.)

Weights at age in the stock (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07600	.08700	.06800
2	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.14200	.12500	.14300
3	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.18700	.15700	.16700
4	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21300	.18600	.18800
5	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.22100	.20200	.21500
6	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.24300	.20900	.22900
7	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.24000	.22200	.23900
8	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27300	.25800	.25400

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	.05800	.07000	.08100	.07700	.07000	.06100	.08800	.07300	.07200	.06700	.06300	.07300
2	.13000	.12400	.12800	.13500	.12100	.11100	.12600	.12600	.12000	.11500	.11900	.12100
3	.16000	.16000	.15500	.16300	.15300	.13600	.15700	.15400	.14700	.14800	.14800	.15000
4	.17500	.17000	.17400	.17500	.16700	.15100	.17100	.17400	.16800	.16200	.16700	.16600
5	.19400	.18000	.18400	.18800	.18000	.15900	.18300	.18100	.18000	.17700	.17800	.17900
6	.21000	.19800	.19500	.19600	.18900	.17100	.19100	.19000	.18500	.19500	.18900	.19000
7	.21800	.21200	.20500	.20700	.19500	.17900	.19800	.20300	.19700	.19900	.20600	.20000
8	.22900	.23200	.21800	.21700	.21400	.19100	.21400	.21400	.21200	.21200	.21400	.23000

Natural Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000
3	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000
4	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
5	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
6	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
7	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
8	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000
3	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000
4	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
5	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
6	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
7	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
8	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000

Table 7.5.2. (cont.)

Proportion of fish spawning

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800
2	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800
2	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500	.8500
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE-STRUCTURED INDICES

FLT07: Mean eastern age 1 (Catch: Thousands)

AGE	1992	1993	1994	1995	1996	1997	1998
1	156.00	100.00	198.00	30.00	65.00	102.00	109.00

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	.1659	.1042	.2136	.1519	.2291	.1570	.1029	.1412	.0594	.0357	.0350	.0088	.0140	.0258	.0419
2	.3608	.3433	.8237	.7503	.7894	.8538	.5320	.7462	1.0531	.3964	.2594	.1849	.1205	.2735	.3928
3	.5161	.6119	1.0074	.9043	.9704	.9860	.9153	.8534	1.2934	.3628	.2562	.1434	.1694	.4122	.3578
4	.5209	.4106	.9954	.8139	1.0917	.9788	.8898	.8136	.8500	.5926	.4195	.1856	.1315	.5004	.3479
5	.5818	.5053	.7313	.9305	.8829	1.0495	.6435	.7240	1.0370	.5121	.1122	.1273	.1954	.3438	.2810
6	.5743	.3888	.7401	.6372	.9316	.6938	.9383	.9188	.6656	.4111	.4415	.2136	.1371	.3346	.2250
7	.4585	.3990	.7591	.7083	.8329	.8012	.7088	.7218	.8465	.4061	.2727	.1523	.1330	.3348	.2779
8	.4585	.3990	.7591	.7083	.8329	.8012	.7088	.7218	.8465	.4061	.2727	.1523	.1330	.3348	.2779

Table 7.5.2. (cont.)

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	.0126	.0357	.0119	.0312	.0461	.0991	.0311	.0400	.0342	.0355	.0568	.0442
2	.2808	.2727	.1945	.3044	.3075	.3877	.3728	.4805	.4099	.4264	.6813	.5304
3	.2883	.5584	.2602	.2848	.2761	.3866	.2975	.3835	.3271	.3404	.5438	.4234
4	.2254	.6027	.3695	.3269	.2109	.4577	.2521	.3250	.2772	.2884	.4608	.3588
5	.2549	.5596	.2747	.4735	.2530	.3537	.2946	.3797	.3239	.3370	.5383	.4191
6	.2485	.4935	.2565	.3697	.3258	.3873	.2444	.3151	.2688	.2796	.4467	.3478
7	.2268	.4497	.2442	.3122	.2411	.3500	.2521	.3250	.2772	.2884	.4608	.3588
8	.2268	.4497	.2442	.3122	.2411	.3500	.2521	.3250	.2772	.2884	.4608	.3588

Population Abundance (1 January) x 10 ^ 6

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	414.94	668.05	349.57	369.57	263.43	325.40	249.20	139.73	159.53	227.30	233.64	234.82	133.10	150.27	172.72
2	176.72	129.31	221.44	103.86	116.80	77.07	102.31	82.71	44.63	55.30	80.69	82.99	85.63	48.29	53.87
3	73.13	91.26	67.96	71.99	36.33	39.30	24.31	44.52	29.05	11.54	27.56	46.12	51.10	56.23	27.21
4	33.97	35.73	40.52	20.32	23.86	11.27	12.00	7.97	15.53	6.53	6.57	17.47	32.71	35.32	30.49
5	32.60	18.26	21.45	13.55	8.15	7.25	3.83	4.46	3.20	6.01	3.26	3.91	13.13	25.95	19.38
6	16.18	16.48	9.97	9.34	4.84	3.05	2.30	1.82	1.96	1.03	3.26	2.64	3.11	9.77	16.65
7	7.57	8.25	10.11	4.30	4.47	1.72	1.38	.81	.66	.91	.61	1.89	1.93	2.46	6.33
8	4.75	8.28	3.20	3.38	2.34	2.12	.72	.59	.42	.75	1.67	.44	4.04	2.67	3.79

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	281.77	117.21	154.54	118.72	69.90	202.08	72.79	224.21	102.24	96.82	103.36	136.70	129.59
2	60.94	102.36	41.61	56.18	42.33	24.56	67.33	25.96	79.24	36.35	34.37	35.93	48.12
3	26.95	34.09	57.74	25.37	30.70	23.06	12.35	34.36	11.89	38.97	17.58	12.88	15.66
4	15.58	16.54	15.97	36.44	15.63	19.07	12.83	7.51	19.17	7.02	22.70	8.36	6.91
5	19.48	11.25	8.19	9.99	23.78	11.45	10.92	9.02	4.91	13.15	4.76	12.96	5.28
6	13.24	13.66	5.82	5.63	5.63	16.71	7.27	7.36	5.58	3.21	8.49	2.51	7.71
7	12.03	9.34	7.54	4.07	3.52	3.68	10.26	5.15	4.86	3.86	2.20	4.92	1.61
8	8.64	12.18	9.47	6.31	3.99	1.39	3.99	7.52	6.29	5.71	4.06	1.19	3.86

Table 7.5.2. (cont.)

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1972	414930	94694	34882	27350	.7841	.5108	112
1973	668040	107902	33605	22600	.6725	.4520	100
1974	349560	93293	25096	38640	1.5397	.8596	99
1975	369570	69470	17294	24500	1.4166	.8072	102
1976	263420	54816	13069	21250	1.6259	.9332	99
1977	325390	49636	9667	15410	1.5940	.9124	95
1978	249190	43688	11152	11080	.9935	.7838	92
1979	139730	35452	9901	12338	1.2461	.8112	92
1980	159520	29308	5878	10613	1.8055	.9798	97
1981	227290	31165	8128	4377	.5385	.4550	90
1982	233630	38807	13539	4855	.3586	.2978	98
1983	234820	45239	19601	3933	.2007	.1710	98
1984	133100	44021	24752	4066	.1643	.1508	96
1985	150270	43024	18631	9187	.4931	.3729	102
1986	172720	40178	18499	7440	.4022	.3209	97
1987	281770	42461	18043	5823	.3227	.2596	103
1988	117200	38698	17116	10172	.5943	.4974	105
1989	154530	35821	16060	4949	.3081	.2711	100
1990	118710	32432	14834	6312	.4255	.3519	101
1991	69900	24205	13017	4398	.3379	.2747	100
1992	202070	26668	9130	5270	.5772	.3946	101
1993	72780	25293	11840	4409	.3724	.2923	101
1994	224210	31921	10058	4828	.4800	.3768	102
1995	102240	26045	11201	5076	.4531	.3214	99
1996	96810	22502	10099	5301	.5249	.3344	100
1997	103360	20768	7723	6651	.8611	.5342	100
1998	136700	21699	6904	3718	.5385	.4159	100

IFAP run code: I24

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 8
Year range in the analysis : 1972 . . . 1998
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 24
Number of observations : 49

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1993	.2521	29	.1413	.4499	.1877	.3388	.2634
2	1994	.3250	31	.1759	.6005	.2376	.4446	.3413
3	1995	.2772	35	.1380	.5569	.1942	.3957	.2953
4	1996	.2884	41	.1278	.6508	.1904	.4369	.3144
5	1997	.4608	53	.1610	1.3191	.2694	.7880	.5321
6	1998	.3588	74	.0829	1.5519	.1699	.7574	.4743
Separable Model: Selection (S) by age								
7	1	.1232	50	.0458	.3316	.0744	.2042	.1400
8	2	1.4785	24	.9230	2.3682	1.1626	1.8802	1.5218
9	3	1.1801	21	.7685	1.8121	.9481	1.4687	1.2087
	4	1.0000	Fixed : Reference Age					
10	5	1.1682	18	.8130	1.6787	.9709	1.4056	1.1884
11	6	.9695	18	.6807	1.3807	.8094	1.1612	.9854
	7	1.0000	Fixed : Last true age					

Table 7.5.2. (cont.)

Separable model: Populations in year 1998

12	1	136701	43	58826	317668	88906	210189	149955
13	2	35924	44	14912	86542	22938	56260	39726
14	3	12883	60	3933	42197	7033	23600	15473
15	4	8355	63	2390	29199	4412	15819	10243
16	5	12954	63	3704	45300	6839	24536	15885
17	6	2513	68	651	9705	1261	5007	3187
18	7	4914	67	1299	18584	2493	9687	6187

Separable model: Populations at age

19	1993	10261	43	4373	24073	6641	15854	11279
20	1994	5153	37	2448	10845	3525	7532	5538
21	1995	4857	39	2259	10440	3287	7177	5241
22	1996	3859	43	1642	9068	2496	5968	4244
23	1997	2196	49	835	5773	1341	3596	2480

Age-structured index catchabilities
FLT07: Mean eastern age 1 (Catch: Thousands)

Linear model fitted. Slopes at age :

24 1 Q .1166E-02 25 .9117E-03 .2493E-02 .1166E-02 .1949E-02 .1558E-02

Table 7.5.2. (cont.)

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1993	1994	1995	1996	1997	1998
1	-.781	-1.041	.387	.912	.969	-.478
2	-.222	-.212	-.086	.464	.360	-.363
3	.039	.198	.114	-.049	.115	-.324
4	.101	-.085	.174	-.369	-.087	.339
5	.089	-.058	-.077	.004	-.144	.178
6	.066	.103	-.084	.043	-.248	.102
7	.000	-.066	-.192	.041	.081	.093

AGE-STRUCTURED INDEX RESIDUALS

FLT07: Mean eastern age 1 (Catch: Thousands)

Age	1992	1993	1994	1995	1996	1997	1998
1	.0379	.5864	.1482	-.9560	-.1278	.2661	.0478

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1993 to 1998

Variance	.0877
Skewness test stat.	.2547
Kurtosis test statistic	-.5689
Partial chi-square	.1991
Significance in fit	.0000
Degrees of freedom	19

Table 7.5.2. (cont.)

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT07: Mean eastern age 1 (Catch: Thousa

Linear catchability relationship assumed

Age	1
Variance	.2285
Skewness test stat.	-1.1609
Kurtosis test statisti	.3102
Partial chi-square	.3204
Significance in fit	.0006
Number of observations	7
Degrees of freedom	6
Weight in the analysis	1.0000

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	6.4970	49	24	25	.2599
Catches at age	5.1263	42	23	19	.2698
Aged Indices					
FLT07: Mean eastern age 1 (Catch: Thou	1.3708	7	1	6	.2285

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	3.0372	49	24	25	.1215
Catches at age	1.6665	42	23	19	.0877
Aged Indices					
FLT07: Mean eastern age 1 (Catch: Thou	1.3708	7	1	6	.2285

Table 7.5.3. Investigation of the effect of F shrinkage on the ICA assessment of herring in VIIa(N), using the GFS-east tuning index. Unshrunk assessment: mean $F_{(2-6)}$ = 0.4159, SSB = 6,904 t.

	Minimum CV of the mean			
Shrinkage	**0.5**		**0.0**	
over years	$F_{(2-6)}$	SSB	$F_{(2-6)}$	SSB
3	0.4189	6,945	0.4202	6,934
5	0.3979	7,115	0.3901	7,181
10	0.3672	7,412	0.3471	7,610
15	0.3529	7,573	0.3281	7,837

Table 7.5.4. Herring in VIIa(N): Conventional VPA with Fishing Mortality Shrinkage

Fs shrunk over 10 years

Minimum CV of the mean taken as .00000

Shrinkage Diagnostics

F from model fit		Historic Mean F			Shrunk estimate
Estimate	Variance	Estimate	Variance	Wt for F from Model	
.044	.592	.038	.029	.046	.038
.530	.472	.389	.012	.024	.392
.423	.531	.344	.005	.010	.345
.359	.558	.324	.006	.011	.324
.419	.561	.355	.006	.010	.356
.348	.589	.319	.004	.006	.319
.359	.558	.305	.004	.007	.304
*****	.411	.305	.004	.010	.304

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	.1660	.1043	.2135	.1517	.2290	.1563	.1027	.1401	.0596	.0346	.0346	.0087	.0140	.0262	.0426
2	.3614	.3435	.8242	.7493	.7880	.8531	.5287	.7436	1.0377	.3987	.2502	.1826	.1186	.2736	.3995
3	.5239	.6135	1.0086	.9057	.9674	.9818	.9134	.8426	1.2808	.3525	.2583	.1373	.1668	.4039	.3579
4	.5311	.4206	1.0013	.8163	1.0965	.9706	.8803	.8096	.8254	.5787	.4021	.1875	.1251	.4898	.3378
5	.6220	.5219	.7637	.9450	.8892	1.0627	.6318	.7072	1.0242	.4842	.1085	.1205	.1978	.3227	.2724
6	.6456	.4340	.7873	.6952	.9689	.7045	.9704	.8828	.6355	.4011	.4041	.2054	.1287	.3400	.2070
7	.6275	.4855	.9353	.8080	1.0114	.8808	.7312	.7799	.7715	.3760	.2635	.1355	.1270	.3094	.2840
8	.6275	.4855	.9353	.8080	1.0114	.8808	.7312	.7799	.7715	.3760	.2635	.1355	.1270	.3094	.2840

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	.0126	.0355	.0117	.0312	.0465	.0962	.0160	.0151	.0405	.0715	.1423	.0384
2	.2870	.2727	.1934	.2988	.3075	.3921	.2775	.4233	.3933	.5890	.8727	.3922
3	.2953	.5773	.2602	.2827	.2693	.3866	.3162	.4186	.4000	.3354	.5931	.3446
4	.2256	.6262	.3897	.3269	.2090	.4417	.2832	.3056	.3053	.2190	.4297	.3241
5	.2450	.5601	.2914	.5142	.2530	.3494	.3101	.3675	.3003	.3144	.4812	.3559
6	.2386	.4659	.2568	.4015	.3692	.3873	.2590	.3440	.2497	.2902	.2992	.3187
7	.2046	.4247	.2250	.3127	.2700	.4190	.2336	.2898	.2923	.3418	.5663	.3043
8	.2046	.4247	.2250	.3127	.2700	.4190	.2336	.2898	.2923	.3418	.5663	.3043

Population Abundance (1 January) x 10 ^ 6

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	414.75	667.78	349.83	369.95	263.55	326.76	249.74	140.80	158.81	234.39	236.30	238.29	133.06	148.23	169.62
2	176.48	129.25	221.34	103.96	116.94	77.11	102.81	82.91	45.02	55.04	83.30	83.97	86.90	48.27	53.12
3	72.28	91.09	67.91	71.92	36.41	39.40	24.34	44.89	29.20	11.82	27.37	48.05	51.83	57.18	27.20
4	33.47	35.05	40.38	20.28	23.80	11.33	12.08	7.99	15.82	6.64	6.80	17.31	34.29	35.91	31.26
5	31.04	17.81	20.82	13.42	8.11	7.19	3.88	4.53	3.22	6.27	3.37	4.12	12.98	27.38	19.91
6	14.85	15.08	9.56	8.78	4.72	3.02	2.25	1.87	2.02	1.05	3.50	2.73	3.30	9.64	17.94
7	5.97	7.05	8.84	3.94	3.96	1.62	1.35	.77	.70	.97	.63	2.11	2.02	2.63	6.21
8	3.75	7.07	2.80	3.09	2.08	2.00	.70	.56	.45	.80	1.72	.49	4.22	2.85	3.72

Table 7.5.4. (cont.)

Population Abundance (1 January) x 10 ^ 6

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	281.77	117.79	157.01	118.71	69.29	207.78	64.18	207.49	127.17	121.54	112.59	136.70	129.59
2	59.80	102.36	41.82	57.09	42.33	24.33	69.43	23.24	75.19	44.93	41.62	35.93	48.40
3	26.39	33.25	57.74	25.53	31.37	23.06	12.18	38.97	11.27	37.59	18.47	12.88	17.98
4	15.57	16.08	15.28	36.44	15.76	19.62	12.82	7.27	20.99	6.19	22.00	8.36	7.47
5	20.18	11.24	7.78	9.36	23.78	11.57	11.41	8.74	4.84	14.00	4.50	12.96	5.47
6	13.72	14.29	5.81	5.26	5.07	16.71	7.38	7.57	5.48	3.25	9.25	2.51	8.21
7	13.20	9.78	8.11	4.07	3.19	3.17	10.26	5.15	4.86	3.86	2.20	6.20	1.65
8	9.47	12.75	10.18	6.30	3.61	1.20	4.27	8.30	6.01	4.94	3.46	1.37	5.05

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1972	414750	92981	33310	27350	.8211	.5368	112
1973	667770	106586	32400	22600	.6975	.4667	100
1974	349830	92570	24400	38640	1.5836	.8770	99
1975	369940	69146	16961	24500	1.4445	.8223	102
1976	263540	54607	12855	21250	1.6530	.9420	99
1977	326750	49694	9628	15410	1.6005	.9146	95
1978	249740	43818	11218	11080	.9877	.7849	92
1979	140790	35648	10002	12338	1.2335	.7972	92
1980	158800	29448	6042	10613	1.7565	.9607	97
1981	234380	31825	8281	4377	.5285	.4430	90
1982	236290	39524	13932	4855	.3485	.2846	98
1983	238290	46130	20137	3933	.1953	.1666	98
1984	133060	44754	25381	4066	.1602	.1474	96
1985	148220	43450	19177	9187	.4791	.3660	102
1986	169620	40367	18890	7440	.3938	.3149	97
1987	281770	42905	18499	5823	.3148	.2583	103
1988	117790	38876	17253	10172	.5895	.5004	105
1989	157000	36125	16157	4949	.3063	.2783	100
1990	118700	32387	14760	6312	.4276	.3648	101
1991	69280	24033	12889	4398	.3412	.2816	100
1992	207770	26965	9102	5270	.5789	.3914	101
1993	64180	24944	12366	4409	.3565	.2892	101
1994	207480	31182	10407	4828	.4639	.3718	102
1995	127170	27477	11071	5076	.4585	.3297	99
1996	121530	24799	10078	5301	.5260	.3496	100
1997	112580	22196	7849	6651	.8473	.5352	100
1998	136700	21997	7610	3718	.4886	.3471	100

IFAP run code: I24

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Table 7.6.1. Herring in Division VIIa(N)

13:53 Sunday, March 21, 1999
Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Prediction with management option table: Input data

Year: 1999								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	129.590	1.0000	0.0800	0.9000	0.7500	0.068	0.0369	0.070
2	48.400	0.3000	0.8500	0.9000	0.7500	0.118	0.4427	0.119
3	17.980	0.2000	1.0000	0.9000	0.7500	0.149	0.3533	0.147
4	7.470	0.1000	1.0000	0.9000	0.7500	0.165	0.2994	0.163
5	5.470	0.1000	1.0000	0.9000	0.7500	0.178	0.3498	0.178
6	8.210	0.1000	1.0000	0.9000	0.7500	0.191	0.2903	0.188
7	1.650	0.1000	1.0000	0.9000	0.7500	0.202	0.2994	0.197
8+	5.050	0.1000	1.0000	0.9000	0.7500	0.219	0.2994	0.217
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2000								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	140.000	1.0000	0.0800	0.9000	0.7500	0.068	0.0369	0.070
2	.	0.3000	0.8500	0.9000	0.7500	0.118	0.4427	0.119
3	.	0.2000	1.0000	0.9000	0.7500	0.149	0.3533	0.147
4	.	0.1000	1.0000	0.9000	0.7500	0.165	0.2994	0.163
5	.	0.1000	1.0000	0.9000	0.7500	0.178	0.3498	0.178
6	.	0.1000	1.0000	0.9000	0.7500	0.191	0.2903	0.188
7	.	0.1000	1.0000	0.9000	0.7500	0.202	0.2994	0.197
8+	.	0.1000	1.0000	0.9000	0.7500	0.219	0.2994	0.217
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	140.000	1.0000	0.0800	0.9000	0.7500	0.068	0.0369	0.070
2	.	0.3000	0.8500	0.9000	0.7500	0.118	0.4427	0.119
3	.	0.2000	1.0000	0.9000	0.7500	0.149	0.3533	0.147
4	.	0.1000	1.0000	0.9000	0.7500	0.165	0.2994	0.163
5	.	0.1000	1.0000	0.9000	0.7500	0.178	0.3498	0.178
6	.	0.1000	1.0000	0.9000	0.7500	0.191	0.2903	0.188
7	.	0.1000	1.0000	0.9000	0.7500	0.202	0.2994	0.197
8+	.	0.1000	1.0000	0.9000	0.7500	0.219	0.2994	0.217
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANRDN04
Date and time: 21MAR99:15:21

Table 7.6.2.a. Herring in Division VIIa(N)

13:53 Sunday, March 21, 1999
Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.3471	22416	8275	4022	0.0000	0.0000	23744	11976	0	28941	16524
.	.	.	.	.	0.1000	0.0347	.	11603	487	28435	15579
.	.	.	.	.	0.2000	0.0694	.	11242	957	27947	14691
.	.	.	.	.	0.3000	0.1041	.	10893	1411	27476	13857
.	.	.	.	.	0.4000	0.1388	.	10556	1849	27023	13073
.	.	.	.	.	0.5000	0.1736	.	10229	2273	26585	12336
.	.	.	.	.	0.6000	0.2083	.	9913	2683	26163	11643
.	.	.	.	.	0.7000	0.2430	.	9608	3078	25756	10992
.	.	.	.	.	0.8000	0.2777	.	9312	3461	25363	10379
.	.	.	.	.	0.9000	0.3124	.	9026	3830	24984	9803
.	.	.	.	.	1.0000	0.3471	.	8749	4188	24618	9262
.	.	.	.	.	1.1000	0.3818	.	8482	4533	24265	8752
.	.	.	.	.	1.2000	0.4165	.	8222	4867	23924	8272
.	.	.	.	.	1.3000	0.4512	.	7972	5190	23595	7821
.	.	.	.	.	1.4000	0.4859	.	7729	5503	23278	7397
.	.	.	.	.	1.5000	0.5207	.	7495	5805	22971	6997
.	.	.	.	.	1.6000	0.5554	.	7267	6098	22675	6620
.	.	.	.	.	1.7000	0.5901	.	7048	6381	22389	6266
.	.	.	.	.	1.8000	0.6248	.	6835	6654	22113	5932
.	.	.	.	.	1.9000	0.6595	.	6629	6919	21846	5618
.	.	.	.	.	2.0000	0.6942	.	6430	7176	21588	5322
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANRDN04
Date and time : 21MAR99:15:21
Computation of ref. F: Simple mean, age 2 - 6
Basis for 1999 : F factors

Table 7.6.2.b. Herring in Division VIIa(N)

13:53 Sunday, March 21, 1999

Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.2666	0.4396	22416	7614	4880	0.0000	0.0000	22869	11203	0	28122	15767
.	.	.	.	.	0.1000	0.0347	.	10853	460	27643	14867
.	.	.	.	.	0.2000	0.0694	.	10514	905	27181	14022
.	.	.	.	.	0.3000	0.1041	.	10186	1334	26736	13227
.	.	.	.	.	0.4000	0.1388	.	9870	1749	26306	12481
.	.	.	.	.	0.5000	0.1736	.	9563	2150	25892	11779
.	.	.	.	.	0.6000	0.2083	.	9267	2537	25493	11119
.	.	.	.	.	0.7000	0.2430	.	8980	2911	25107	10499
.	.	.	.	.	0.8000	0.2777	.	8703	3272	24736	9916
.	.	.	.	.	0.9000	0.3124	.	8435	3622	24377	9368
.	.	.	.	.	1.0000	0.3471	.	8176	3960	24031	8852
.	.	.	.	.	1.1000	0.3818	.	7925	4286	23697	8366
.	.	.	.	.	1.2000	0.4165	.	7682	4602	23375	7910
.	.	.	.	.	1.3000	0.4512	.	7447	4907	23064	7480
.	.	.	.	.	1.4000	0.4859	.	7220	5202	22764	7076
.	.	.	.	.	1.5000	0.5207	.	7000	5488	22474	6695
.	.	.	.	.	1.6000	0.5554	.	6788	5764	22194	6336
.	.	.	.	.	1.7000	0.5901	.	6582	6032	21924	5999
.	.	.	.	.	1.8000	0.6248	.	6383	6290	21663	5681
.	.	.	.	.	1.9000	0.6595	.	6190	6540	21411	5382
.	.	.	.	.	2.0000	0.6942	.	6004	6783	21168	5100
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANRDN02
Date and time : 21MAR99:15:22
Computation of ref. F: Simple mean, age 2 6
Basis for 1999 : TAC constraints

Table 7.6.2.c. Herring in Division VIIa(N)

13:53 Sunday, March 21, 1999

Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.8855	0.6544	22416	6287	6600	0.0000	0.0000	21130	9669	0	26493	14264
.	.	.	.	.	0.1000	0.0347	.	9364	408	26068	13454
.	.	.	.	.	0.2000	0.0694	.	9069	802	25658	12692
.	.	.	.	.	0.3000	0.1041	.	8784	1182	25262	11977
.	.	.	.	.	0.4000	0.1388	.	8509	1549	24881	11305
.	.	.	.	.	0.5000	0.1736	.	8242	1904	24514	10673
.	.	.	.	.	0.6000	0.2083	.	7985	2247	24160	10079
.	.	.	.	.	0.7000	0.2430	.	7736	2578	23819	9521
.	.	.	.	.	0.8000	0.2777	.	7496	2898	23489	8996
.	.	.	.	.	0.9000	0.3124	.	7263	3207	23172	8502
.	.	.	.	.	1.0000	0.3471	.	7038	3505	22865	8038
.	.	.	.	.	1.1000	0.3818	.	6821	3794	22569	7601
.	.	.	.	.	1.2000	0.4165	.	6610	4073	22284	7190
.	.	.	.	.	1.3000	0.4512	.	6407	4343	22009	6803
.	.	.	.	.	1.4000	0.4859	.	6210	4604	21743	6438
.	.	.	.	.	1.5000	0.5207	.	6020	4857	21487	6096
.	.	.	.	.	1.6000	0.5554	.	5836	5101	21239	5773
.	.	.	.	.	1.7000	0.5901	.	5659	5337	21000	5469
.	.	.	.	.	1.8000	0.6248	.	5487	5566	20769	5182
.	.	.	.	.	1.9000	0.6595	.	5320	5787	20547	4912
.	.	.	.	.	2.0000	0.6942	.	5159	6001	20331	4658
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANRDN03
Date and time : 21MAR99:15:21
Computation of ref. F: Simple mean, age 2 - 6
Basis for 1999 : TAC constraints

Table 7.6.3a. Herring in Division VIIa(N)

13:53 Sunday, March 21, 1999
Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.0000	0.3471	29990	4022	223820	22416	97337	13452	57663	8275
2000	1.0000	0.3471	31103	4188	237865	23744	102174	14172	60812	8749
2001	1.0000	0.3471	32894	4444	243976	24618	107730	14981	64242	9262
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRRDN03
Date and time : 21MAR99:15:57
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

Table 7.6.3b. Herring in Division VIIa(N)

13:53 Sunday, March 21, 1999
Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.2666	0.4396	36426	4880	223820	22416	97337	13452	53095	7614
2000	1.0000	0.3471	29668	3960	232469	22869	96844	13305	57323	8176
2001	1.0000	0.3471	32060	4296	240700	24031	104454	14394	61957	8852
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRRDN01
Date and time : 21MAR99:15:58
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

Table 7.6.3c. Herring in Division VIIa(N)

13:53 Sunday, March 21, 1999
Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1999	1.8855	0.6545	49386	6600	223820	22416	97337	13452	43962	6287
2000	1.0000	0.3471	26808	3505	221740	21130	86270	11584	50405	7038
2001	1.0000	0.3471	30403	4002	234195	22865	97950	13228	57424	8038
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRRDN02
Date and time : 21MAR99:15:58
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

Table 7.6.4. Herring in Division VIIa(N)

13:53 Sunday, March 21, 1999
Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Single option prediction: Detailed tables

Year: 1999 F-factor: 1.2666 Reference F: 0.4396

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0467	3755	263	129590	8812	10367	705	4695	319
2	0.5607	18198	2166	48400	5711	41140	4855	19833	2340
3	0.4475	5923	871	17980	2679	17980	2679	10345	1541
4	0.3792	2251	367	7470	1233	7470	1233	4926	813
5	0.4431	1870	333	5470	974	5470	974	3406	606
6	0.3677	2411	453	8210	1568	8210	1568	5471	1045
7	0.3792	497	98	1650	333	1650	333	1088	220
8+	0.3792	1521	330	5050	1106	5050	1106	3330	729
Total		36426	4880	223820	22416	97337	13452	53095	7614
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2000 F-factor: 1.0000 Reference F: 0.3471

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0369	3216	225	140000	9520	11200	762	5118	348
2	0.4427	14215	1692	45497	5369	38672	4563	20732	2446
3	0.3533	5553	816	20466	3049	20466	3049	12817	1910
4	0.2994	2323	379	9410	1553	9410	1553	6668	1100
5	0.3498	1303	232	4626	823	4626	823	3133	558
6	0.2903	764	144	3178	607	3178	607	2270	434
7	0.2994	1269	250	5143	1039	5143	1039	3644	736
8+	0.2994	1024	222	4149	909	4149	909	2940	644
Total		29668	3960	232469	22869	96844	13305	57323	8176
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2001 F-factor: 1.0000 Reference F: 0.3471

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0369	3216	225	140000	9520	11200	762	5118	348
2	0.4427	15509	1846	49637	5857	42192	4979	22619	2669
3	0.3533	5874	864	21649	3226	21649	3226	13558	2020
4	0.2994	2905	474	11769	1942	11769	1942	8340	1376
5	0.3498	1778	316	6311	1123	6311	1123	4274	761
6	0.2903	709	133	2950	563	2950	563	2108	403
7	0.2994	531	105	2151	434	2151	434	1524	308
8+	0.2994	1538	334	6232	1365	6232	1365	4416	967
Total		32060	4296	240700	24031	104454	14394	61957	8852
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRRDN01
Date and time : 21MAR99:15:51
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

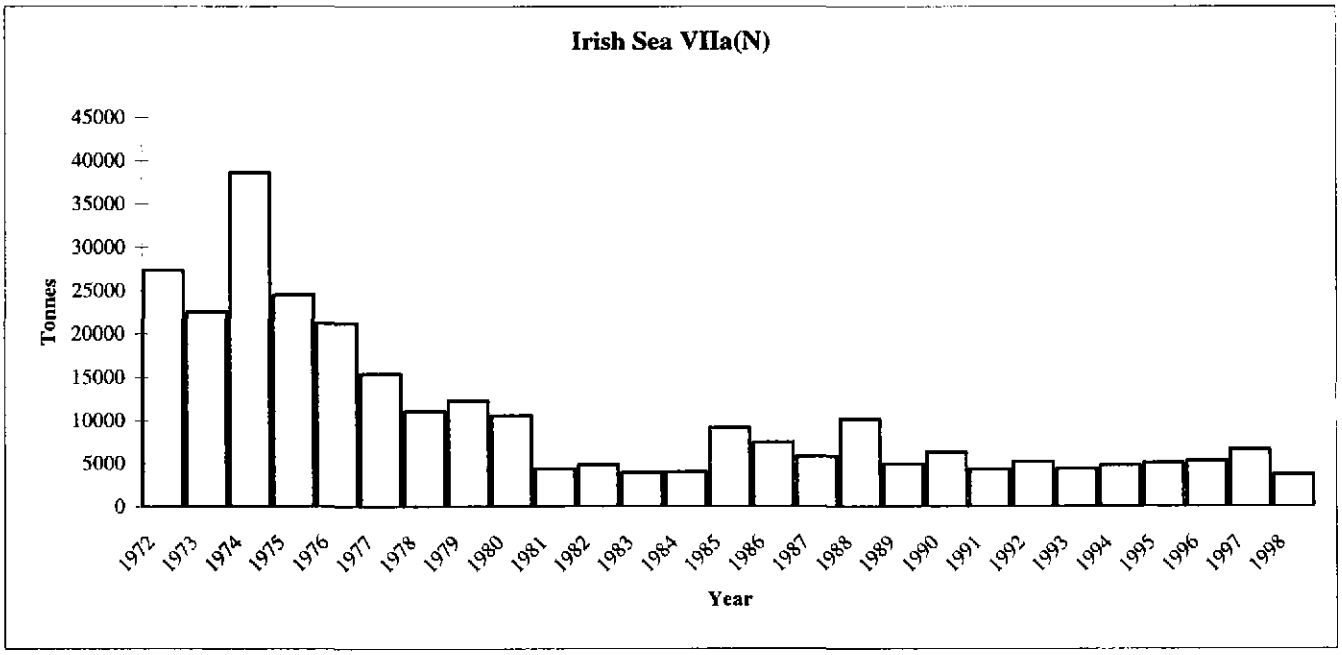


Figure 7.1.1. Landings of herring (tonnes) from the Irish Sea VIIa(N) 1972-1998

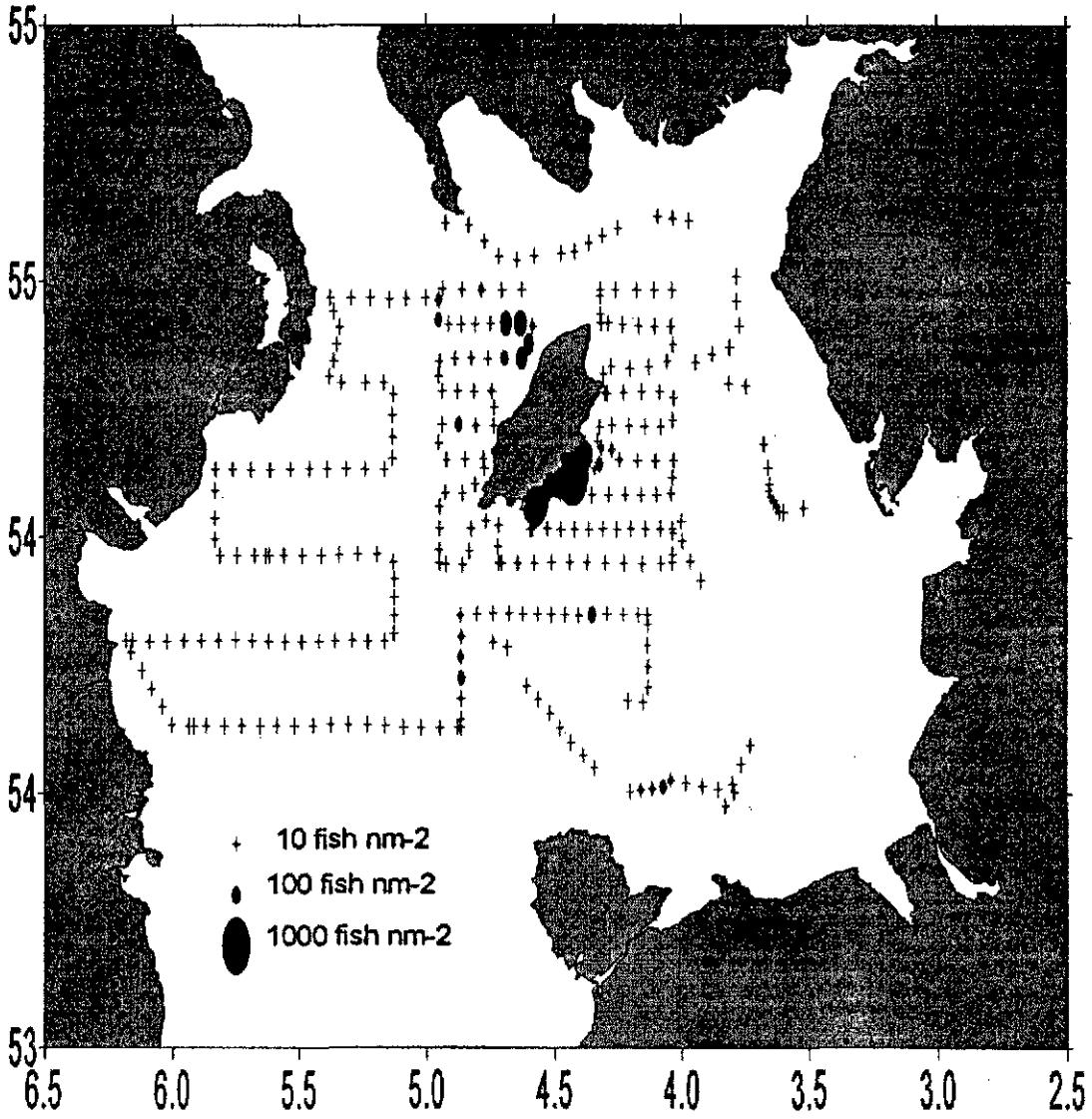


Figure 7.3.1 Distribution of herring (aged 3+) in September 1998 in the Irish Sea (VIIaN) as determined by acoustic survey. The size of the elipses is proportional to the square root of fish density (N $m.mi^{-2}$)

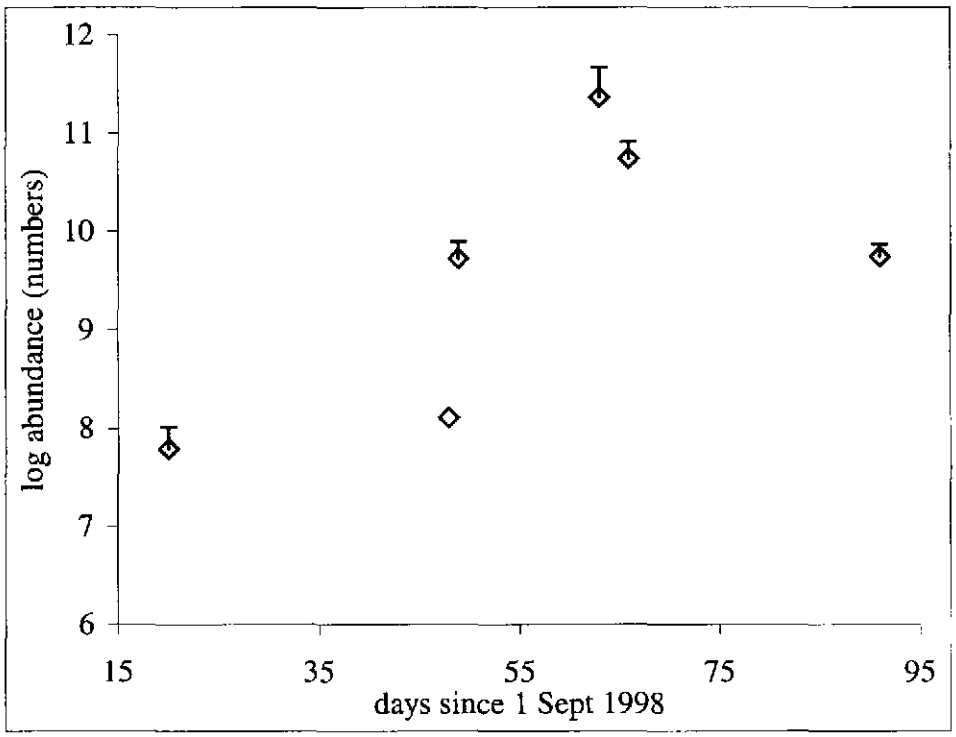


Figure 7.3.2 Abundance of herring larvae on the Douglas Bank, 1998
Errors bars denote 1 standard error.

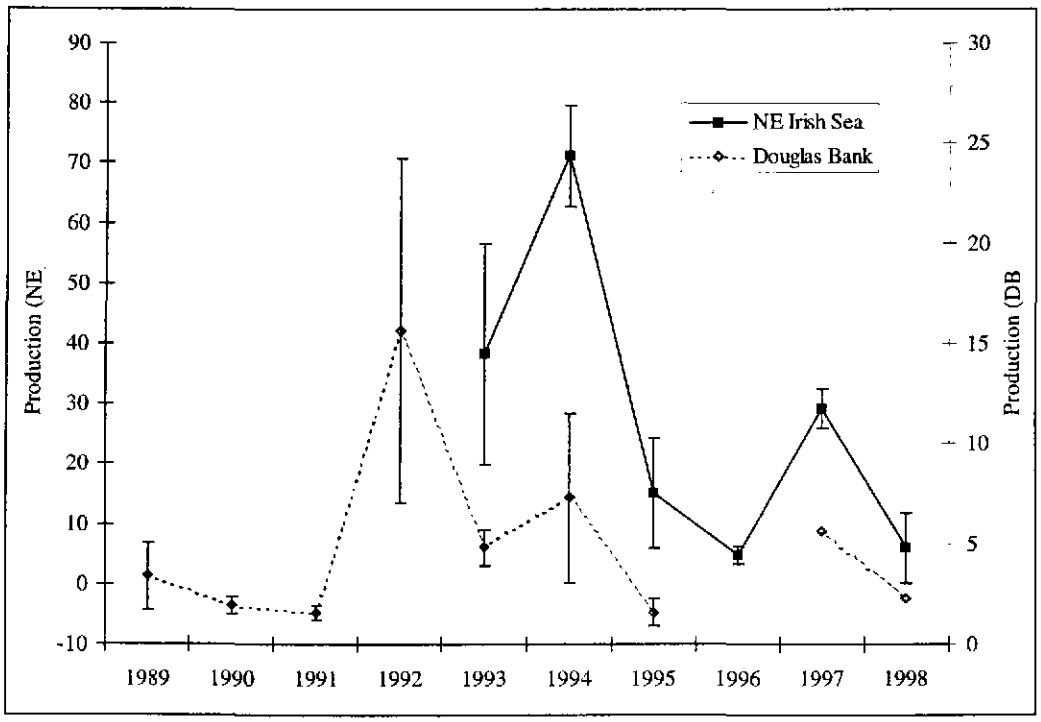


Figure 7.3.3 Larval production estimates of eastern Irish Sea herring from two series of surveys.

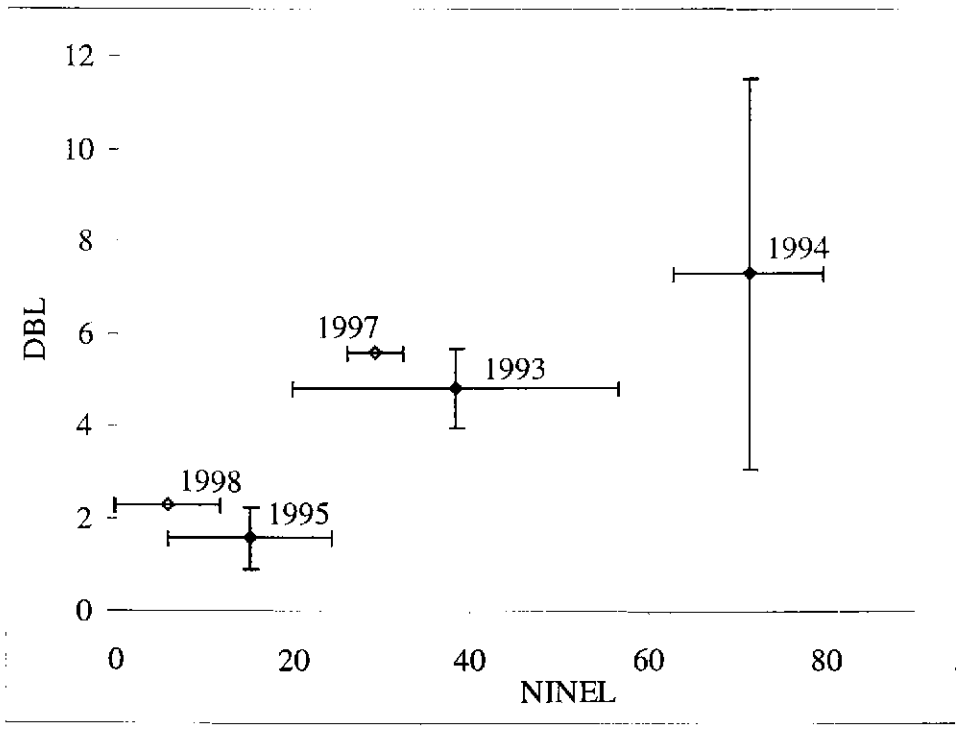


Figure 7.3.4 Comparison of larval production estimates from Douglas Bank (DBL) and North Eastern Irish Sea (NINEL) surveys (1994-1998).

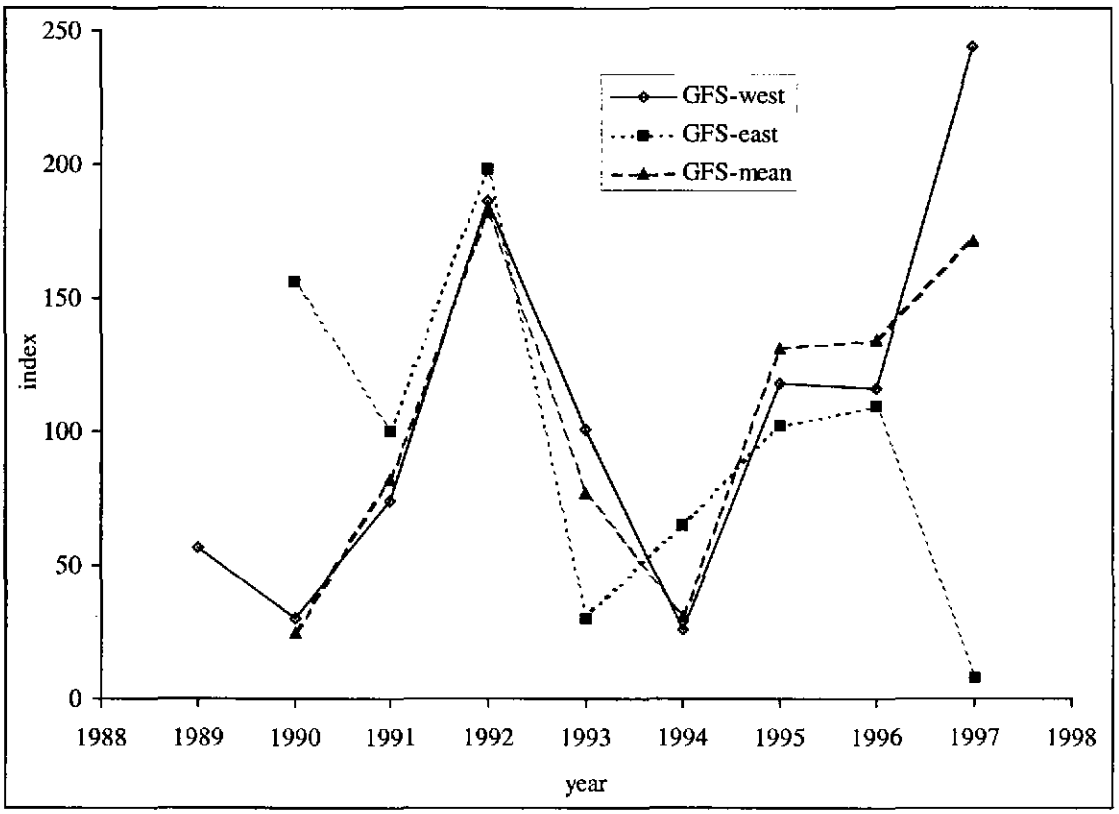


Figure 7.3.5 Index of ground fish survey of Irish Sea herring (1989-1997).
Index of abundance (mean of 3 cruises, weighted by inverse of CVs) over year class

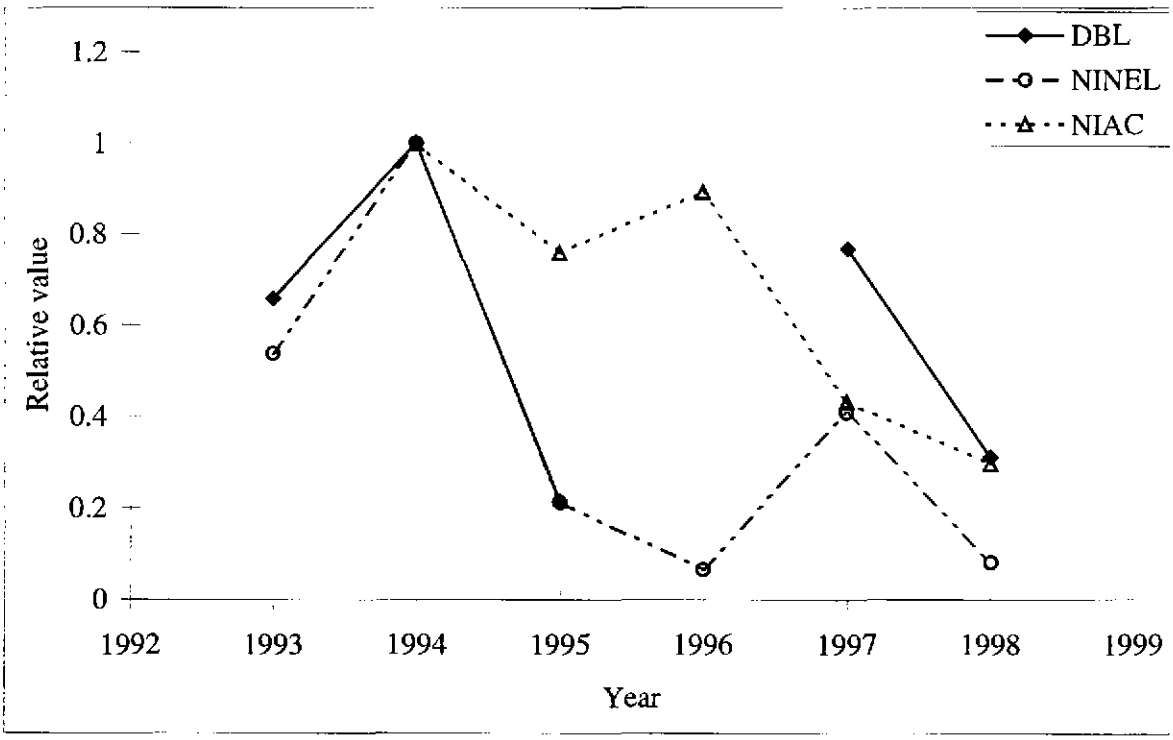


Fig. 7.4.1. Relative changes in SSB indices for Division VIIa(N).

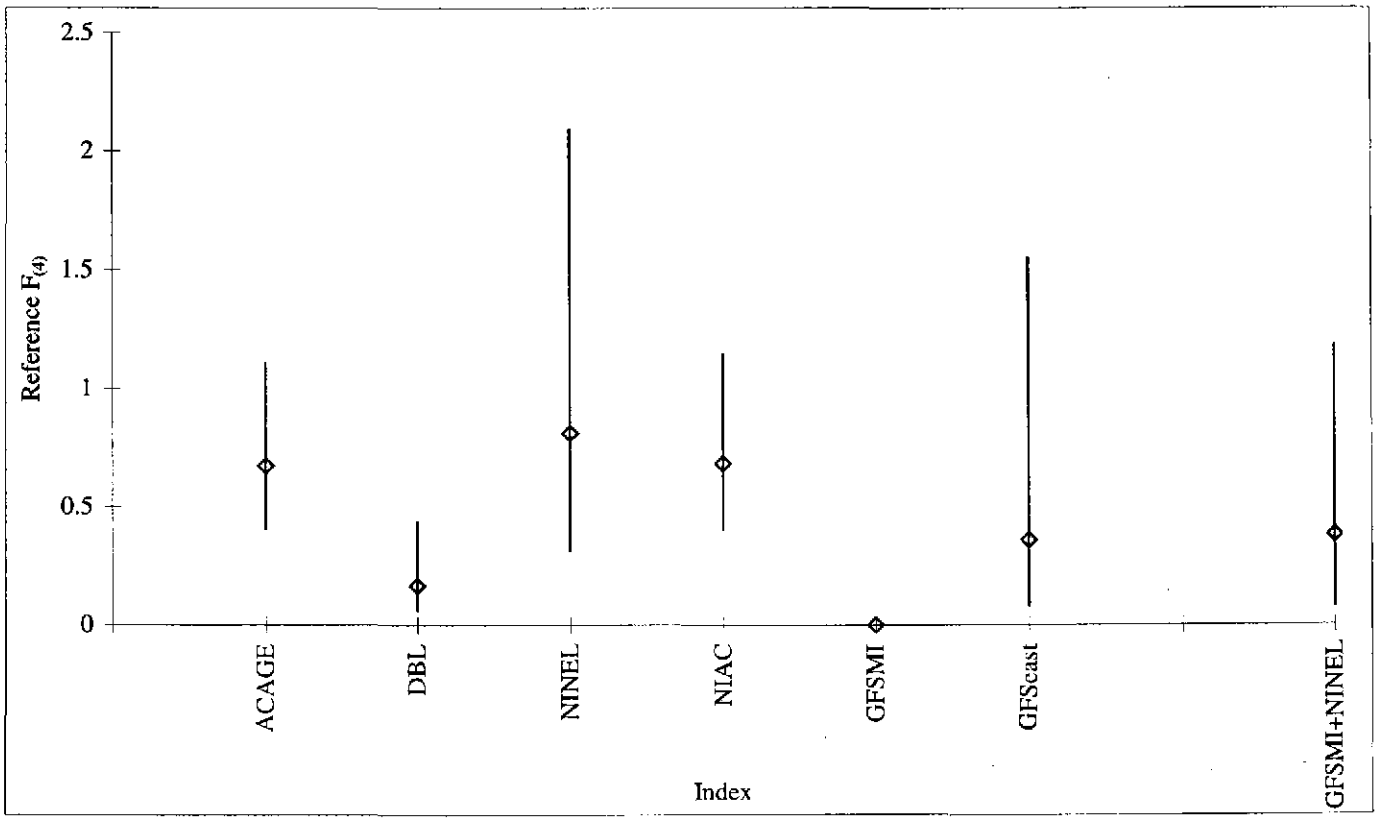


Figure 7.4.2. Herring Irish Sea VIIa(N): Tuning indices and reference F.
95% confidence limits shown.

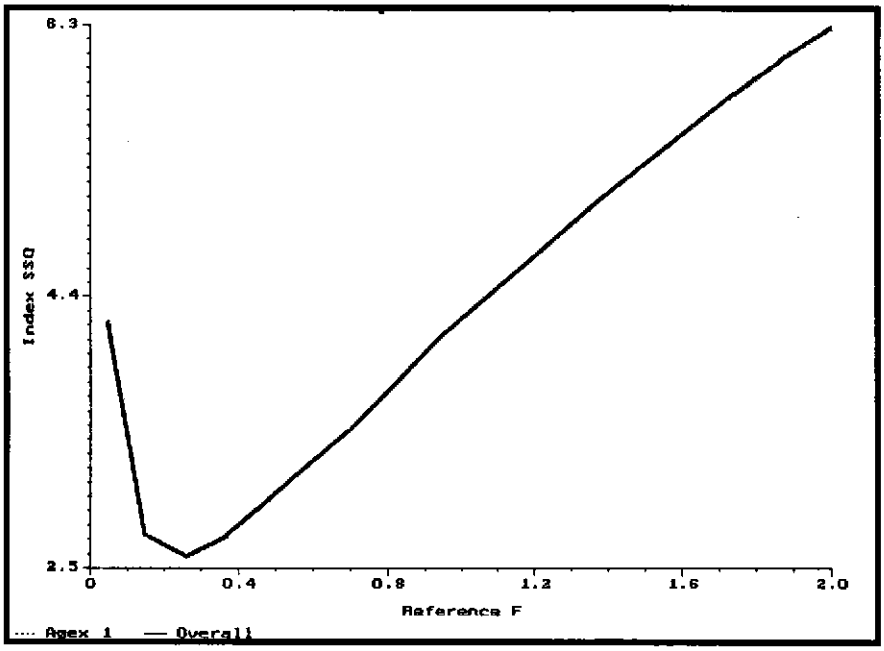


Figure 7.5.1. Herring in VIIa(N). SSQ surface for the baseline assessment. Agex 1 = I-ringer index in the Irish Sea (GFS-east).

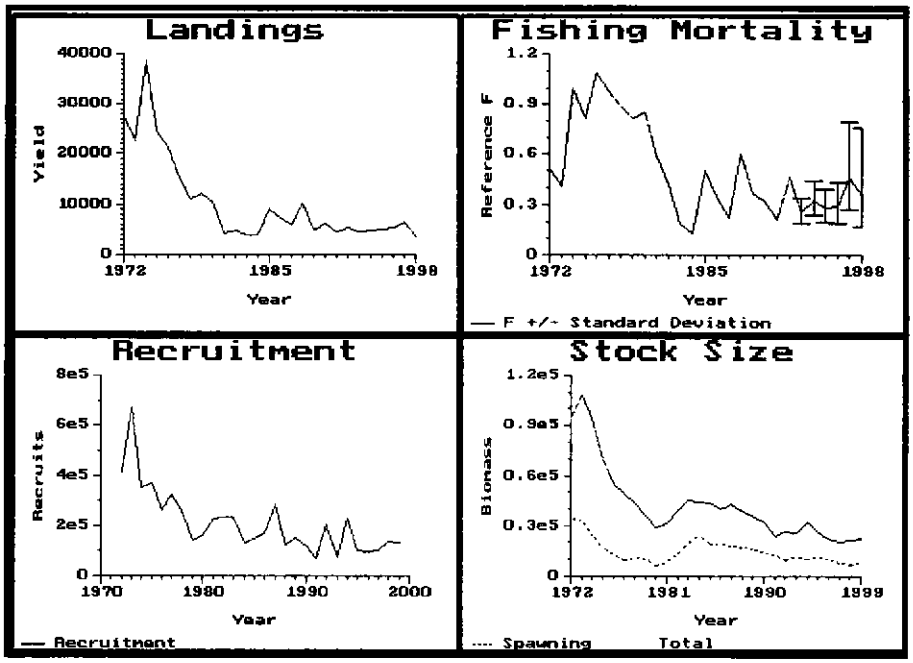


Figure 7.5.2. Herring in VIIa(N). Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

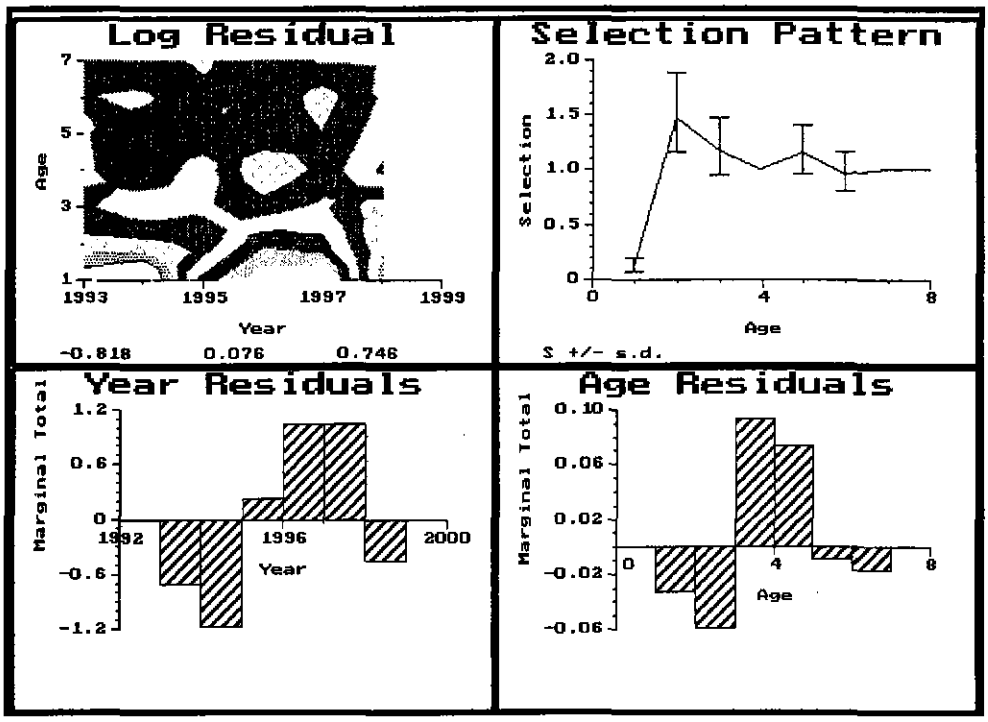


Figure 7.5.3. Herring in VIIa(N). Results of baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

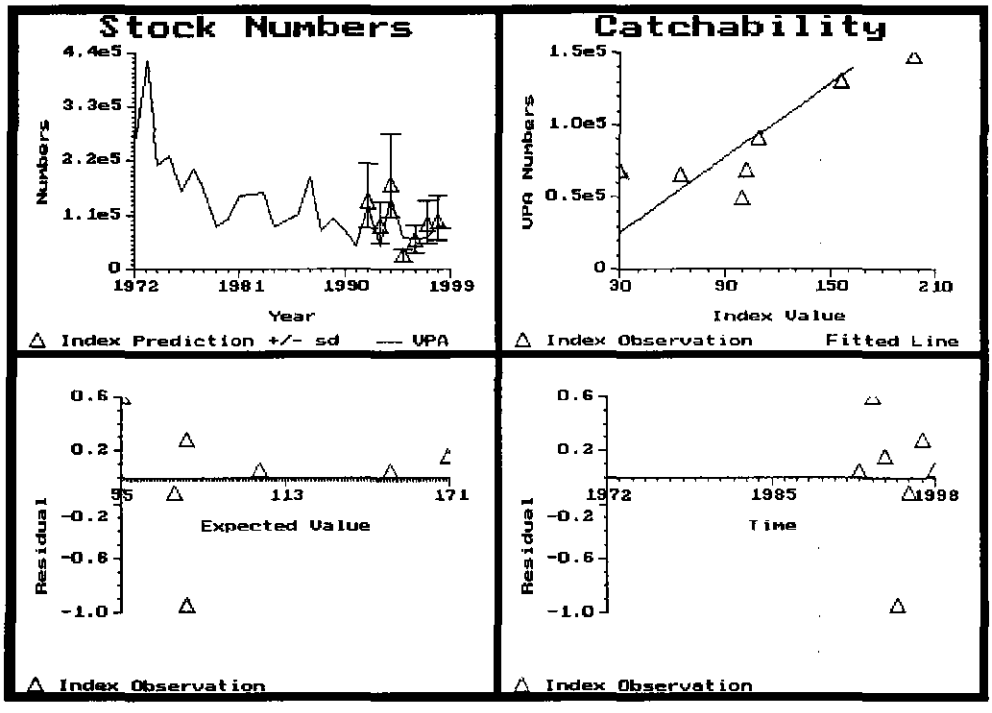
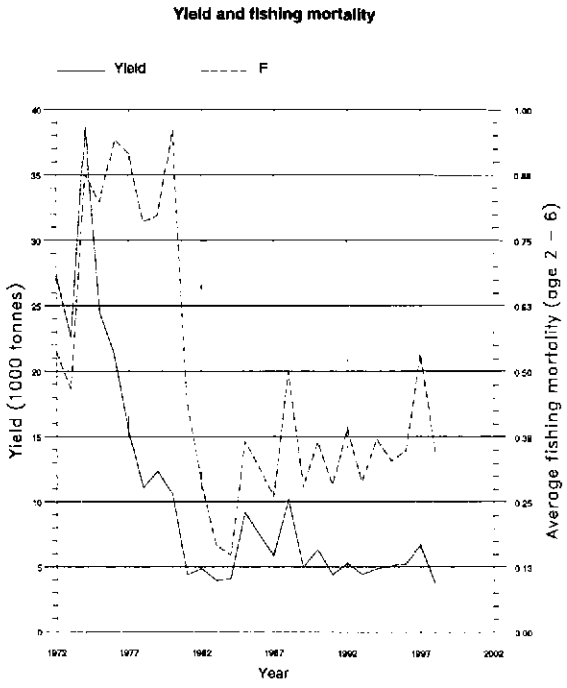
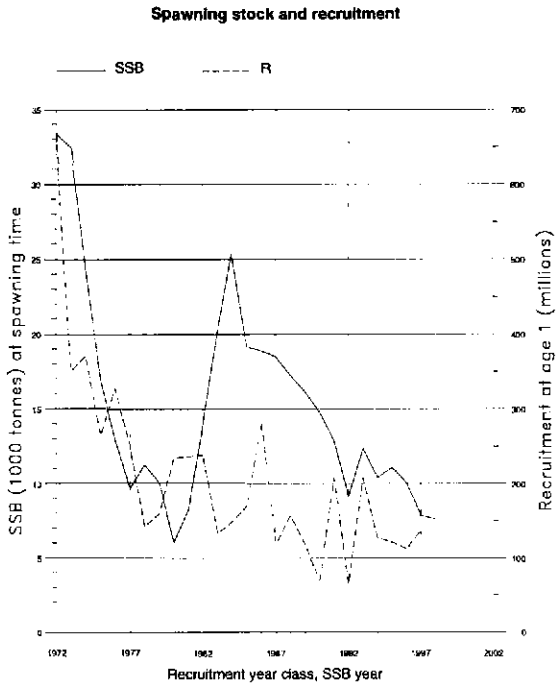


Figure 7.5.4. Herring in VIIa(N). Results of baseline assessment. Diagnostics of the fit of the 1-ringer index GFS-east against the estimated populations at age 1-ring. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and 1-ringer survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

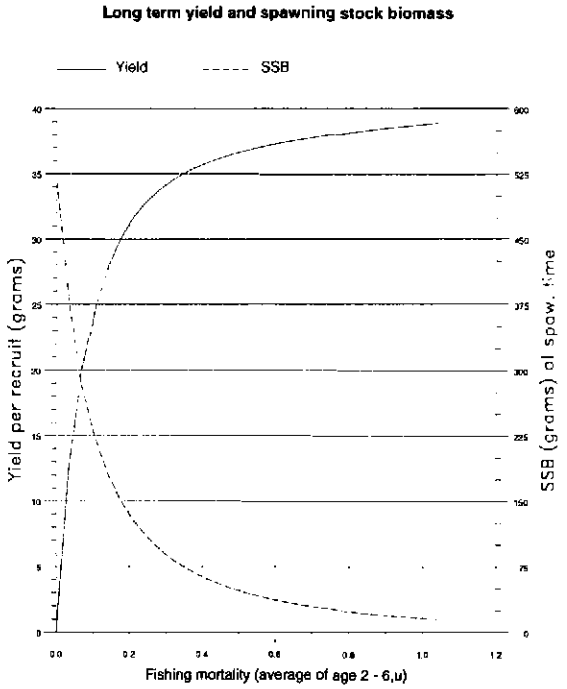
Figure 7.5.5. Herring in Division VIIa(N)



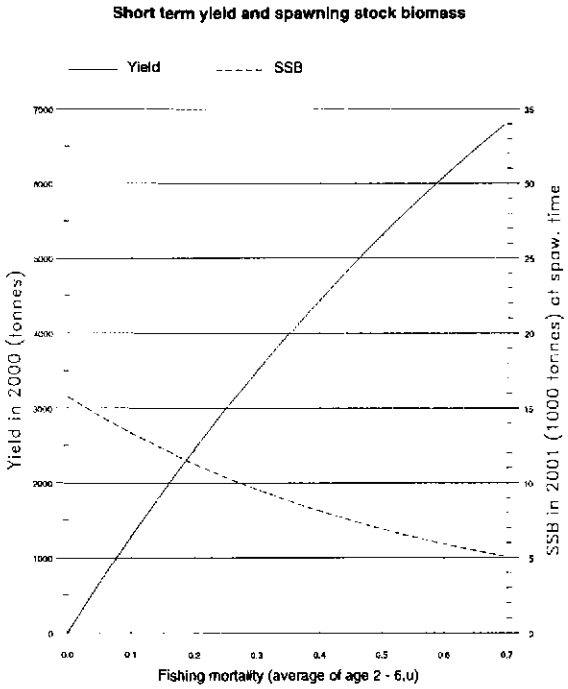
(run: ICARDN24) A



(run: ICARDN24) B

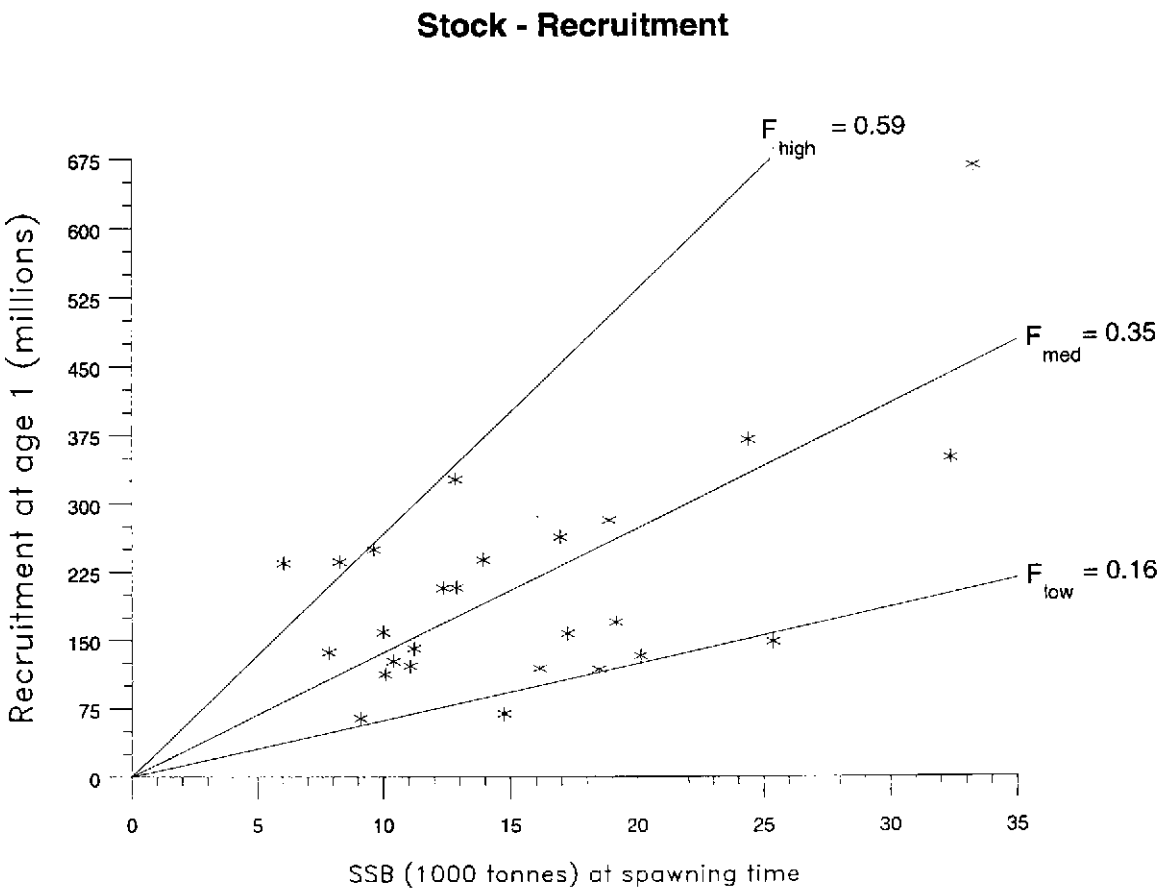


(run: YLDRDN01) C



(run: MANRDN02) D

Figure 7.5.6. Herring in Division VIIa(N).



(run: ICARDN24)

8 SPRAT IN THE NORTH SEA

8.1 The Fishery

8.1.1 ACFM advice applicable for 1998 and 1999

There has been no ACFM advice on sprat TAC in recent years. The TAC set by management was 200,000 t for 1996 [Sub-area IV(EU zone) + Division IIa (EU zone)] and 150,000 t for 1997. The agreed TAC for 1998 was 150,000 t.

Again at its meeting in May 1998 ACFM did not give any advice on a sprat TAC for the North Sea. The management agreement between the EU and Norway set a TAC of 175,000 t for 1999.

8.1.2 Total landings in 1998

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1985–1998. As in previous years, sprats from the fjords of western Norway are not included in the landings for the North Sea. Landings from the fjords are presented separately (Table 8.1.2) due to their uncertain stock identity. Table 8.1.3 shows the landings for 1994–1998 by year, quarter, and area in the North Sea.

The Danish sprat fishery in the North Sea was closed from mid February to the beginning of April 1998 due to the high by-catches of herring in the sprat fishery. There was, however, an exception in that vessels were allowed to land 50 t of sprat per week. The fishery reopened in August with only low by-catches of herring. The fishery ceased in late November as the Danish sprat quota was taken.

Purse seiners prosecute the Norwegian sprat fishery. Most of the Norwegian landings were taken in the second half of the year.

The monthly and annual distributions of catches by rectangle for Sub-area IV are shown in Figures 8.1.1–8.1.13. Again in 1998, the Norwegian catches reportedly from rectangles 41F3, 42F3, 41F4 and 42F4 are probably misreported from other rectangles in Division IVb.

Landing statistics for Denmark, Norway and UK (England and Wales) show that 163,000 t sprat were landed from the North Sea in 1998, which was an increase in landings from 1997 of about 57%. The 1998 landings were lower than any year from 1993 to 1995.

There was a considerable increase in landings from about 10,000 t in 1986 to a peak of 320,600 t in 1995. The Danish landings increased from 99,000 t in 1997 to 131,000 t in1998. The Norwegian landings of 31,000 t in 1998 were 10 times higher than the landings in 1997 (3,000 t), but close to the mean for the period 1991–1996. The 1997 Norwegian landings were the lowest recorded landings since 1990.

8.2 Catch Composition

8.2.1 Catches in number

The estimated quarterly catch-at-age in numbers by country for the years 1994 to 1998 is presented in Table 8.2.1. The data for 1994 to 1997 were revised. Denmark, Norway and UK (England and Wales) provided age composition data of commercial landings in 1998. In 1998 1-group fish dominated (64%) the landings in both the Danish and the Norwegian fleets.

8.2.2 Mean Weight at age

The mean weights (g) at age in catches taken in 1994 - 1998 are presented, by quarter, in Table 8.2.2. Weights were estimated from commercial catch data provided by Working Group members. Catch at age data from commercial landings were available for the two quarters when the majority of the catch is taken (quarters 3 and 4). The landings from these quarters constitute 95% of the total landings from the North Sea. Landings from the 2 nd quarter are negligible.

8.2.3 Quality of catch and biological data

The sampling intensity for biological samples, i.e age and weight at age, is given in Table 8.2.3. The total number of samples available in 1997 were low compared to 1996, but increased in 1998. The sampling intensity for biological samples is too low. The recommended level of one sample per 1,000 t landed was not reached. In 1998, Denmark collected 48 samples from commercial landings and these were analysed for length and age. This gives 0.4 sample per 1,000 t landed. These samples were used to estimate age composition and weight at age of sprat. From the Norwegian landings, 16 samples were taken which gives 0.5 sample per 1,000 t. These samples were also analysed for lengths and age composition.

The Danish monitoring scheme for species composition in the Danish small meshed fisheries in 1998 was working well and a total of 931 samples were collected from landings taken in the North Sea. The total landings from the Danish small mesh fishery in 1998 was 870,000 t (all species). The recommended sampling levels were achieved.

No sprat were reported as by-catch in the landings from the Norwegian small meshed fishery targeted at sandeel and Norway pout

8.3 Recruitment

The IBTS(February) sprat indices (no per hour) are used as an index of abundance. The historical data were revised by the Working Group in 1995 (ICES 1995a). The IBTS-indices for 1984–1999 are presented in Table 8.3.1 for age groups 1–4, 5+ and total, along with the number of rectangles sampled and the number of hauls considered. The fishing method (gear) was standardised in 1983 and the data in the series are comparable.

Table 8.3.1 indicates an increase in the 1-group index from 1996, which is well above the 1-group index for the series. The indices of 2, 3 and 4-groups are below the average. The total 1999-abundance index (4,688) is the third highest in the series.

The IBTS data by rectangle are given in Figure 8.3.1 for age groups 1, 2 and 3+. Age 1-group were found to be concentrated in the south-eastern areas of Division IVb and in IVc. The mean lengths (mm) of age-group 1 by rectangle, are presented in Figure 8.3.2.

8.4 Acoustic Survey

The acoustic surveys for the North Sea Herring in June-July have estimated sprat abundance since 1996. In June-July 1998, sprat were mainly detected west of 1°W (R/V Tridens) (WD Simmonds *et al*, 1999). The acoustic estimates of sprat biomass in 1996–1998 were in the range of 40,000 t (1998) to 210,000 t (1996). The difference is probably due to inapropriate coverage of the distribution area in the southeastern areas (ICES 1999b). These data demonstrate the need for better coverage of the south-southeastern areas of the North Sea.

8.5 State of the Stock

8.5.1 Catch-Survey Data Analysis

The IBTS surveys do not fully reflect strong and weak cohorts for sprat, which has also been demonstrated by previous Working Groups (see ICES 1998a). The 1-:2 group ratio varies between 0.34 (1987 year class) and 7.57 (1988 year class) and does not adequately reflect the age structure of the stock. This may be due to difficulties in age reading and/or a possible prolonged spawning and recruitment season. However, the IBTS-survey may still be a useful indicator of the stock biomass and can be used as a tuning index in production models.

The Biomass dynamic model was fitted using the CEDA program, see ICES 1993a and Holden, Kirkwood and Bravington (1995). The data used were; the total catch for 1972–1998 and the IBTS(February) abundance indices for 1984 to 1998. The initial state of the stock in 1972 was assumed to be 0.8 of the carrying capacity K. The 1989 IBTS index for sprat was again considered as an outlier. A new run was done excluding the 1989 data. The run was consistent with the analyses undertaken in the two last years (ICES 1998a). This analysis shows a slight upward trend in biomass. The run seems to be somewhat sensitive to the proportion of K (initial proportion) assigned to 1972. There is, however, no objective way to determine the size of the initial proportion. A range of proportion values (0,25 to 0.8) were run giving a MSY in the range of 300 -450, 000 t. There were similar trends over the range of proportions. The model fits reasonable well, as shown in Figure 8.5.1.

The difficulties in tracking strong and weak year-classes may be partly due to difficulties in age determination. This year the Working Group had the IBTS- length-composition data per square for 1981–1998 and the annual age-length keys for each of the IBTS-areas available. In order to "smooth out" difficulties in age determination, one age-length key for the North Sea, was calculated by combining the 1995–1999 data. Also, all sprat smaller than 8.5 cm and aged as 2-group were moved to 1-group. The length-composition by square data were combined into area IVb and assigned to age classes based on the new age-length key. This revision gives a 1-:2 group ratio of between 0.95 and 39 (Table 8.5.1). Variation in growth between areas and years was not considered. The 9.0–11.0 cm length groups appear to be a transition between the 1–3 age-groups with potential error in age determinations. The IBTS-length and length at age data series were made available briefly before the meeting and there was no time to exploit the data any further.

8.6 Projections of Catch and Stock

The regression of the total catches and total the IBTS indices for 1984–1998, excluding the 1989-index, predicted a yield for 1999 of 240,000 tonnes ($r^2 = 0.79$), see Fig. 8.6.1.

The total IBTS-indices were used in a SHOT-estimate (see ICES 1992d). The estimated landings for 1999 were approximately 260 000 tonnes (Table 8.6.1). Runs using the "old" 1-group indices (Table 8.3.1) and the "revised" 1-group indices (Table 8.5.1) as inputs, predict landings of 360,000 t and 270,000 t, respectively.

Projections, run in the CEDA package, with annual catches of 100,000 t, 200,000 t and 250,00 t as input values, are shown in Figure 8.5.1. These catch levels were chosen based on the actual catch level and the projections from the regression and the SHOT-estimate.

The biomass dynamic model has some attractions over the SHOT method for stock and catch projections. First, the biomass dynamic model is based on a production function (the Schaefer function, in this case) with parameters (r, K) which are interpretable in terms of population dynamics. The SHOT procedure, although also based on the concept of production, is more ad-hoc, and the estimated parameters are not as easily interpreted. Second, the biomass dynamic model projections give useful indications of how the stock may evolve under different future catches, and the estimated stock dynamics. Nonetheless, the sprat catches are dominated by young fish, and the population is strongly driven by recruitment. Most of the production of the stock is therefore likely to be due to recruitment and the growth of recruits rather than the growth of post-recruits. Care should therefore be taken not to over-interpret the biomass dynamic model.

8.7 Management Considerations

The recruitment between years does not appear to be driven directly by fishing effort. The sprat stock has in the years prior to 1993, in some period been caught with a relative high by-catch percentage of herring. In 1993, 1994 and 1995 the sprat fishery could be conducted with rather low herring by-catch percentages. In some periods in 1997 and 1998 was stopped with the aim of protecting the juvenile herring and because of to high by-catch percentages of herring.

The natural variability in stock abundance is high. With the current management regime, where by-catch ceilings of herring as well as by-catch percentage limits, the sprat fishery can in periods be controlled by these factors. But, as in 1998, the main controlling factor can be the TAC limits.

The sprat stock shows signs of improvement as both catch and biomass appears to increase and there is indication of a good 1998-year class recruiting to the 1999 fishery.

Attempts to assess this stock have demonstrated the need for a better survey coverage of the south-, southeastern areas of the North Sea and for the addition of directed sprat sampling for age data. There is also a need for better knowledge of spawning seasons and recruitment from possible autumn spawners.

Table 8.1.1 Sprat catches in the North Sea ('000 t) 1985–1998. Catch in fjords of western Norway excluded (Data provided by Working Group members except where indicated). These figures do not in all cases correspond to the offical statistics and cannot be used for management purposes.

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998[1]
Division IVa West														
Denmark	0.9	0.6	0.2	0.1	+	-			0.6	-	-	-	-	-
Netherlands	6.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-
UK (Scotland)	6.1	+	+	-	-	+	-	-	-	0.1	+	-	-	-
Total	13.7	0.6	0.2	0.1	+	+	0.1	0.26	0.6	0.1	+	-	-	+
Division IVa East (North Sea) stock														
Denmark	+	0.2	+	+	+	-	-	-	+	+	+	0.3	+	+
Norway	-	-	-	-	-	-	-		2.5	+	+	-	-	-
Sweden	-	-	-	-	-		2.5	-	-	-	-	-	-	-
Total	+	0.2	+	+	+	+	2.5	0.54	2.5	+	+	0.3	+	+
Division IVb West														
Denmark	1.8	0.4	3.4	1.4	2.0	10.0	9.4		13.0	19.0	26.0	1.8	82.2	21.1
Norway	-	-	-	3.5	0.1	1.2		18.4	16.8	12.6	21.0	1.9	2.3	+
UK (England & Wales)	-	-	-	-	-	-	-		0.5	-	+	+	-	-
UK (Scotland)	-	-	0.1	-	-	-	-	-	0.5	-	-	-	-	-
Total	1.8	0.4	3.5	4.9	2.1	11.2	13.8	38.78	30.8	31.6	47.0	3.7	84.5	21.1
Division IVb East														
Denmark	36.6	10.3	28.0	80.7	59.2	59.2	67.0		136.2	251.7	283.2	74.7	10.9	98.3
Germany	0.6		-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	0.6	-	0.6	25.1		24.1	19.1	14.7	50.9	0.8	15.3
Sweden	-	-	-	-	-			-	-	-	0.2	0.5	-	1.7
Total	37.2	10.9	28.0	81.3	59.2	59.8	92.1	76.06	160.3	270.8	298.1	126.1	11.7	115.3
Division IVc														
Belgium	+	+	+	-				-	-	-	-	-	-	-
Denmark	+	0.1	+	0.1	0.5	1.5	1.7		3.5	-	11.4	3.9	5.7	11.8
France	-	+	-	-		-		-	+	+	+	-	-	-
Netherlands	-	-	-	0.4		-		-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	0.4	4.6	0.4	-	0.1	16.0
UK (England and Wales)	3.4	4.1	0.7	0.6	0.9	0.2	1.8		2.0	2.9	0.2	2.6	1.4	0.2
Total	3.4	4.2	0.7	1.1	1.8	1.7	3.5	8.61	5.9	7.5	12.0	6.5	7.2	28.0
Total North Sea														
Belgium	+	+	+	-				-	-	-	-	-	-	-
Denmark	39.3	11.7	31.7	82.3	61.9	69.2	78.1		153.3	284.4	320.6	80.7	98.8	131.1
France	-	+	-	-	+	-		-	+	-	+	-	-	-
Germany	0.6	0.6	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	6.7	-	0.5	0.4	0.4	-		-	-	-	-	-	-	-
Norway	-	-	-	4.1	0.1	1.8	29.6	28.5	43.8	36.3	36.2	54.8	3.2	31.3
Sweden	-	-	-	-	-			-	0.1	-	0.2	0.5	-	-
UK (England and Wales)	3.4	4.1	0.7	0.6	0.9	0.2	1.8		2.6	2.9	0.2	2.6	1.4	-
UK (Scotland)	6.1	+	0.2	-	-	+	-	-	0.5	0.1	+	-	-	0.2
Total	56.1	16.4	33.1	87.4	63.3	71.2	109.5	124.2	200.3	323.7	357.2	136.6	103.4	162.6

[1]Preliminary.
[2]Official statistics.
[3]Includes Division IV a-c.
+Catch recorded, but amount not precisely known.

Table 8.1.2 Sprat catches ('000 t) in the fjords of western Norway, 1984–1998.

1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997[1]	1998[1]
4.4	7.1	2.2	8.3	5.3	2.4	2.7	3.2	3.8	1.9	5.3	3.7	3.3	3.1	2.5

[1]Preliminary.

Table 8.1.3 Sprat catches (tonnes) in the North Sea by quarter*. Catches in fjords of Western Norway excluded.

Year	Quarter	Area					Total
		IVaW	IVaE	IVbW	IVbE	IVc	
1994	1	0	42	2616	17227	16091	35976
	2	0	0	242	10857	2	11101
	3	0	0	10479	184747	3572	198798
	4	97	0	18224	57959	1325	77605
Total		97	42	31561	270790	20990	323480
1995	1	0	0	17752	16900	7324	41976
	2	0	0	1138	5752	1	6891
	3	0	86	25305	183500	6	208897
	4	0	5	2826	92054	4693	99578
Total		0	91	47021	298206	12024	357342
1996	1	0	459	2471	81020	6103	90053
	2	0	0	615	2102	18	2735
	3	0	0	242	6259	0	6501
	4	0	353	411	36273	386	37423
Total		0	812	3739	125654	6507	136712
1997	1	0	0	1025	147	7089	8261
	2	0	0	189	1054	0	1243
	3	0	3	27487	569	0	28059
	4	0	81	55814	9878	0	65773
Total		0	84	84515	11648	7089	103336
1998	1	0	105	1917	3726	1616	7364
	2	4	0	529	209	4	746
	3	0	0	4926	55155	215	60296
	4	0	0	13762	54449	25984	94195
Total		4	105	21134	113359	27819	162601

*1994 data from Denmark and Norway.
1995-1996 data from Denmark, Sweden, Norway and the UK
1997 and 1998 data from Denmark, Norway and the UK (England and Wales)

Table 8.2.1 North Sea Sprat. Catch in numbers (millions) by quarter and by age 1994 -1998

Year	Quarter	Age						Total
		0	1	2	3	4	5+	
1994	1		614.7	2,588.5	715.6	49.4		3,968.2
	2		2,968.0	14.9				2,982.9
	3		27,920.6	310.5				28,231.1
	4	902.5	4,686.9	1,333.9	151.3	3.2	5.5	7,083.3
	Total	902.5	36,190.2	4,247.9	866.9	52.7	5.5	42,265.6
1995	1		5.9	2,990.5	991.4	54.0		4,041.7
	2		2.3	595.1	182.5			779.9
	3	531.3	12,097.4	7,990.0	262.6	3.3		20,884.7
	4		4,541.1	3,309.7	377.8			8,228.6
	Total	531.3	16,646.7	14,885.3	1,814.3	57.3		33,934.8
1996	1		524.7	4,615.4	2,621.9	316.4	11.3	8,089.7
	2		1.9	241.5	32.7	15.5	0.3	291.9
	3		400.5	100.7	22.9	0.3		524.5
	4		1,190.7	1,069.0	339.6	5.6		2,604.8
	Total		2,117.9	6,026.6	3,017.0	337.8	11.5	11,510.8
1997	1		74.4	314.0	229.2	55.3	2.5	675.4
	2		11.3	47.8	34.9	8.4	0.4	102.9
	3		1,991.9					1,991.9
	4	127.6	3,597.2	996.2	117.8	58.1	0.0	4,896.9
	Total	127.6	5,674.8	1,358.1	381.9	121.8	2.8	7,667.1
1998	1		683.2	537.2	18.3	0.1		1,238.8
	2		70.9	55.3	1.8			127.9
	3	74.2	3,356.6	693.3				4,124.2
	4	772.4	4,822.4	2,295.1	483.5	39.5		8,412.8
	Total	846.6	8,933.1	3,580.9	503.6	39.6		13,904

Table 8.2.2 North Sea Sprat. Mean weight (g) by quarter and by age for 1994 - 1998.

Year	Quarter	Age						SOP
		0	1	2	3	4	5+	Tonnes
1994	1		1.8	9.6	12.8	17.4		35,976
	2		3.7	8.0				11,101
	3		7.0	10.8				198,798
	4	8.4	10.4	13.7	18.5	24.7	23.0	77,604
	Total	8.4	7.1	11.0	13.8	17.9	23.0	323,479
1995	1		3.0	9.4	12.9	19.4		41,976
	2		3.0	8.4	10.3			6,891
	3	2.4	7.6	13.9	16.4	20.7		208,897
	4		10.5	13.9	16.2			99,578
	Total	2.4	8.4	12.8	13.8	19.5		357,342
1996	1		3.9	9.3	14.9	15.3	16.1	88,807
	2		6.9	8.4	11.6	20.0	15.2	2,735
	3		11.6	14.2	18.2	21.5		6,501
	4		12.1	15.9	17.2	20.5		37,359
	Total		10.0	10.5	15.1	15.6	16.0	135,401
1997	1		8.0	10.0	15.0	17.0	19.0	8,161
	2		8.0	10.0	15.0	17.0	19.0	1,243
	3		14.2					28,285
	4	3.7	11.9	16.4	19.1	19.6		63,083
	Total	3.7	12.7	14.7	16.3	18.2	19.0	100,772
1998	1		5.6	6.0	8.7	15.0		7,232
	2		5.6	6.0	8.3			743
	3	3.7	14.7	15.3				60,149
	4	4.1	10.6	13.8	16.3	14.6		94,173
	Total	4.0	11.7	12.8	16.0	14.7		162,297

Table 8.2.3 North Sea Sprat. Sampling commercial landings for biological samples in 1996-1998.

Country	Quarter	Landings 000t	No samples	No fish meas.	No fish aged
1996					
Denmark	1	34.2	13	2,635	743
	2	2.7	11	109	
	3	6.5	5	115	
	4	37.3	3	314	337*
	Total	80.7	32	3,173	743
Norway	1	55.8	36	3,459	2,774
	2	0			
	3	0			
	4	0			
	Total	55.8	36	3,459	2,774
Total North Sea		137	68	6,632	3,517
1997					
Denmark	1	6.8	4	408	0
	2	1.2	4	13	0
	3	28.1	4	278	77
	4	62.7	16	1,774	184
	Total	98.8	28	2,473	261
Norway	1	0.1	0	0	0
	2				
	3				
	4	3.1	8	800	785
	Total	3.2	8	800	785
Total North Sea		102	36	3,273	1,046
1998					
Denmark	1	7.2	6	247	0
	2	0.7	11	94	30
	3	60.3	16	1,936	109
	4	62.9	15	2,105	442
	Total	131.1	48	4,382	581
Norway	1	0.2			
	2				
	3				
	4	31.3	16	1,704	1,096
	Total	31.5	16	1,704	1,096
England/Wales	1				
	2				
	3				
	4	0.2	2	657	216
	Total	0.2	2	657	216
Total North Sea		162.8	66	6743	1893

Table 8.3.1 North Sea Sprat. Abundance indices by age group from IBTS(February), 1984-1999, in the standard sprat area (Div. IVb).

Year	No rect.	No hauls	Age					
			1	2	3	4	5+	Total
1984	80	251	383.63	393.57	47.43	6.66	0.41	831.70
1985	79	289	675.49	305.00	38.22	4.32	0.90	1023.93
1986	78	285	68.22	104.77	29.38	1.31	0.26	203.94
1987	78	299	758.28	74.68	24.80	3.61	0.21	861.58
1988	78	208	152.29	1410.52	109.66	8.78	0.00	1681.25
1989	79	236	4293.66	445.72	318.65	4.10	13.44	5075.57
1990	78	192	115.16	567.46	149.83	30.79	0.59	863.83
1991	78	179	834.45	104.89	27.84	2.63	1.17	970.98
1992	79	185	1562.20	344.08	38.25	5.51	0.45	1950.49
1993	79	181	1732.54	602.01	84.12	4.35	0.06	2423.08
1994	78	173	4084.89	1397.77	129.96	2.79	0.67	5616.08
1995	79	166	1059.30	2643.93	134.01	3.23	1.12	3841.59
1996	78	146	346.37	483.45	141.96	23.64	0.56	995.98
1997	79	159	887.43	389.35	33.80	3.42	0.15	1314.15
1998	79	197	1650.35	1744.60	286.34	12.14	2.32	3695.75
1999	78	177	4045.34	538.13	56.00	3.85	44.75	4688.07

Table 8.5.1. Tentative revision of the IBTS-indices

Year class	1	2	1-gr/2-gr
1983	609	183	3.33
1984	812	110	7.38
1985	1986	50	39.72
1986	803	829	0.97
1987	748	779	0.96
1988	4167	500	8.33
1989	250	151	1.66
1990	804	296	2.72
1991	1570	556	2.82
1992	1633	732	2.23
1993	4765	611	7.80
1994	3182	325	9.79
1995	626	122	5.13
1996	1179	1262	0.93
1997	2141		

Table 8.6.1. North Sea Sprat. SHOT forecast of landings in 1999 using total landings and total IBTS-indices as input data.

North Sea sprat — SHOT forecast spreadsheet version 6
Total index — Mars 1999

running recruitment weights

older	0.00		G-M =	0.00
central	1.00		exp(d)	1.00
younger	0.00	ex	exp(d/2)	1.00

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1984	77	832		0.77	0.23				100		
1985	50	1024	1024	0.77	0.23	42			65		
1986	16	204	204	0.77	0.23	6	8	18	21		
1987	33	862	862	0.77	0.23	38	34	29	43		
1988	87	1681	1681	0.77	0.23	103	69	61	113	79	61
1989	63	5076	5076	0.77	0.23	56	254	216	82	280	216
1990	71	864	864	0.77	0.23	73	24	33	92	43	33
1991	110	971	971	0.77	0.23	122	32	41	143	53	41
1992	124	1950	1950	0.77	0.23	128	80	87	161	113	87
1993	200	2423	2423	0.77	0.23	223	109	112	260	146	112
1994	324	5616	5616	0.77	0.23	361	295	273	421	355	273
1995	357	3842	3842	0.77	0.23	367	214	239	464	311	239
1996	137	996	996	0.77	0.23	71	62	130	178	168	130
1997	103	1314	1314	0.77	0.23	93	82	95	134	123	95
1998	163	3696	3696	0.77	0.23	181	232	202	212	263	202
1999		4688	4688	0.77	0.23		286	258	0	335	258

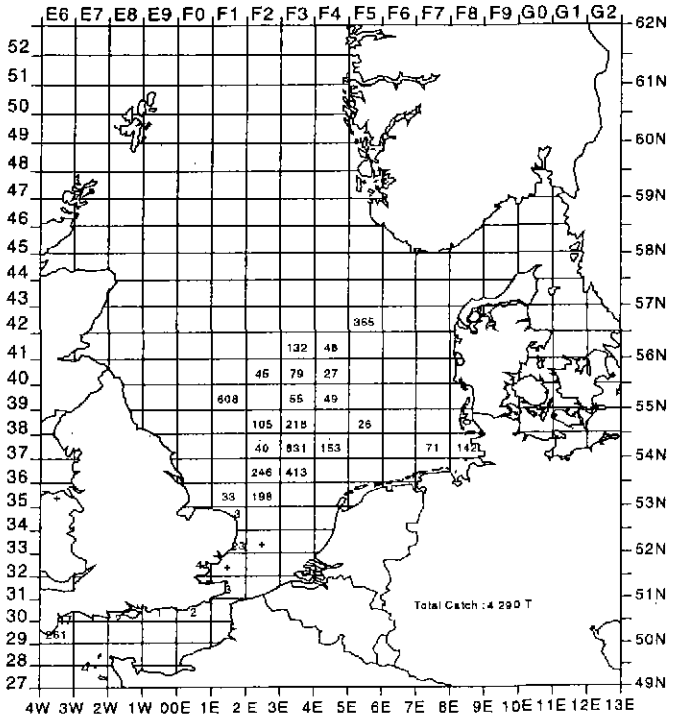


Figure 8.1.1 Sprat North Sea catches (in tonnes). January 1998

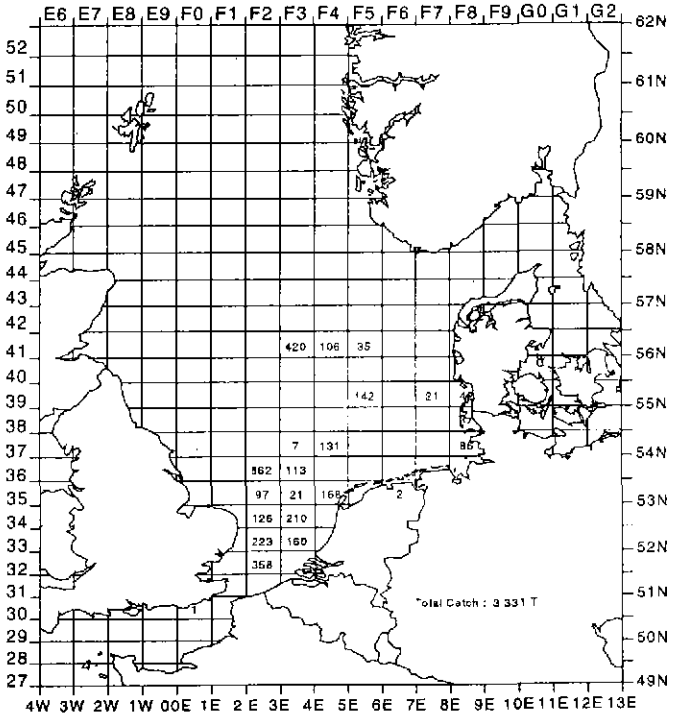


Figure 8.1.2 Sprat North Sea catches (in tonnes). February 1998

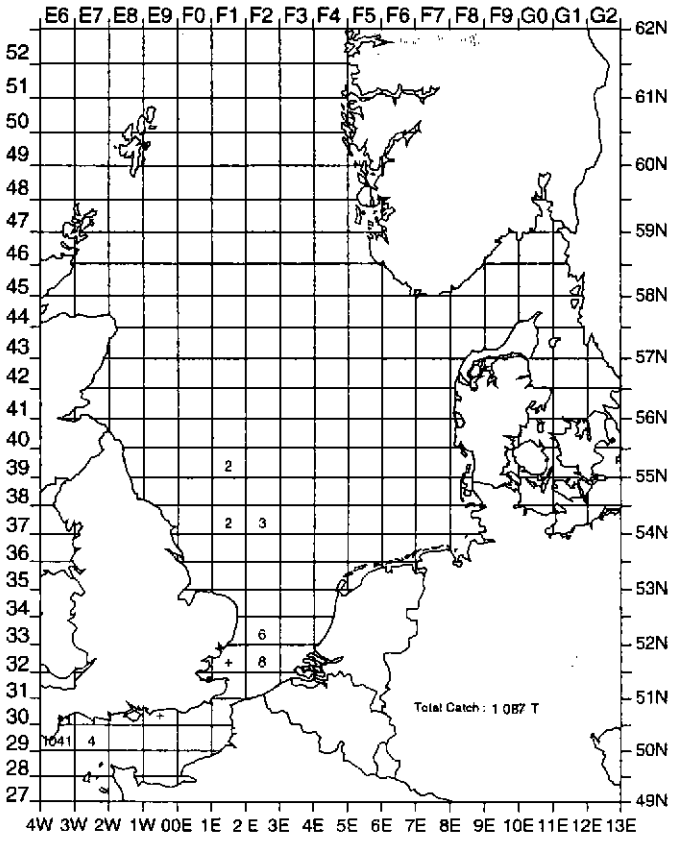


Figure 8.1.3 Sprat North Sea catches (in tonnes). March 1998

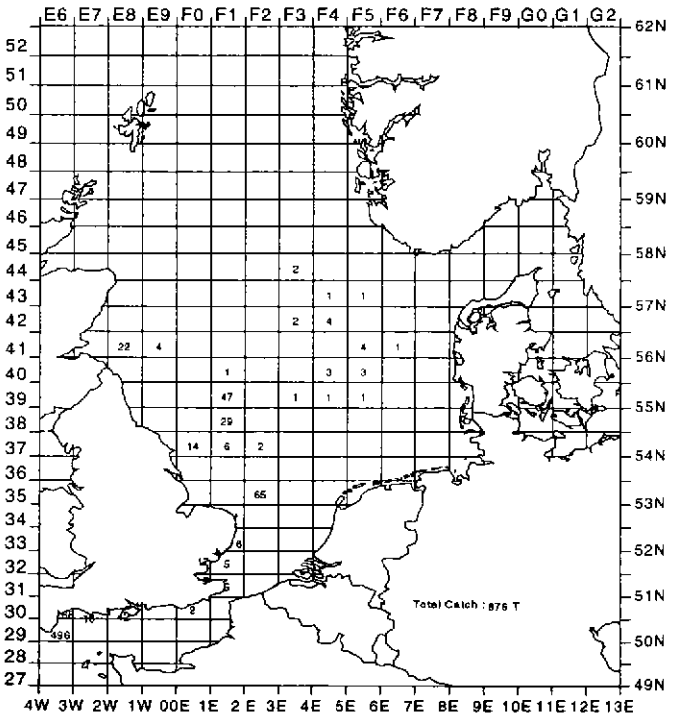


Figure 8.1.4 Sprat North Sea catches (in tonnes). April 1998

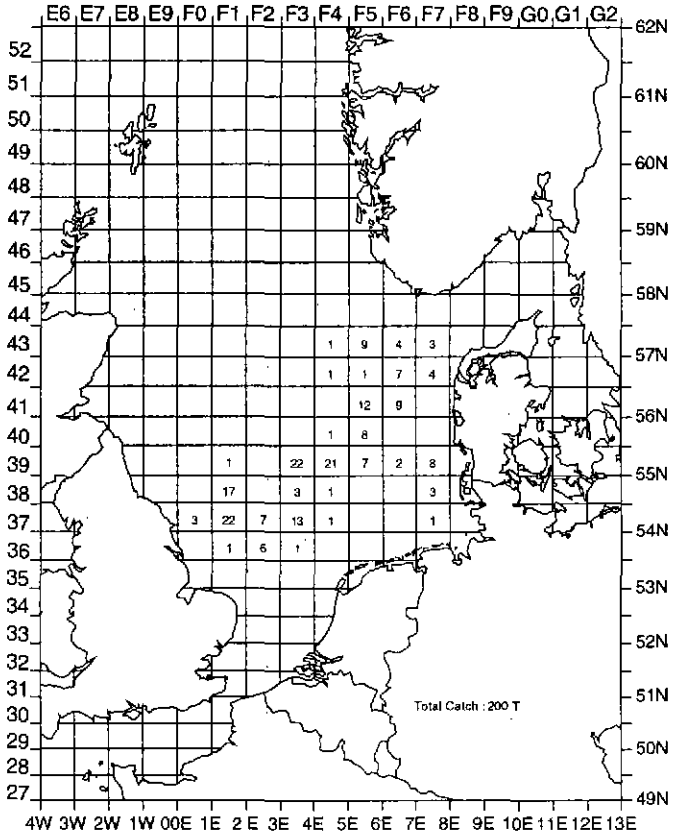


Figure 8.1.5 Sprat North Sea catches (in tonnes). May 1998

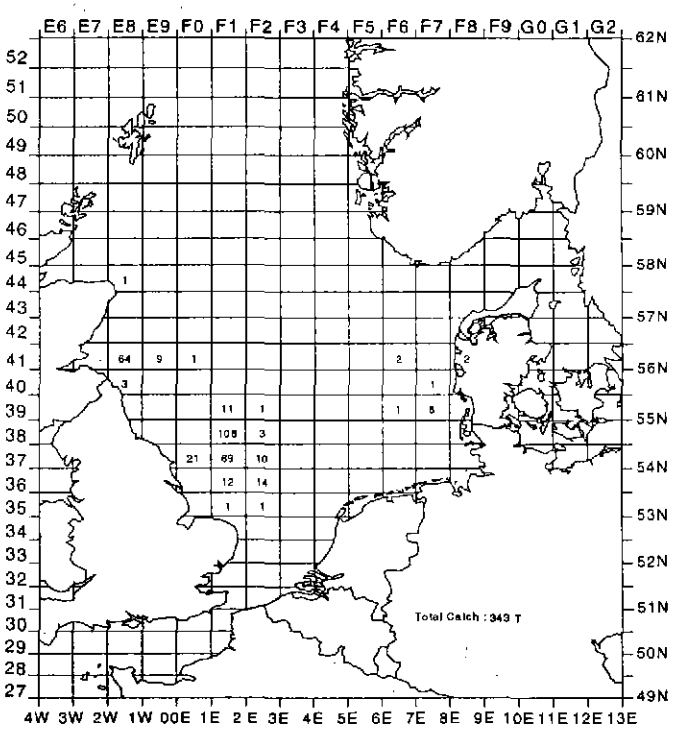


Figure 8.1.6 Sprat North Sea catches (in tonnes). June 1998

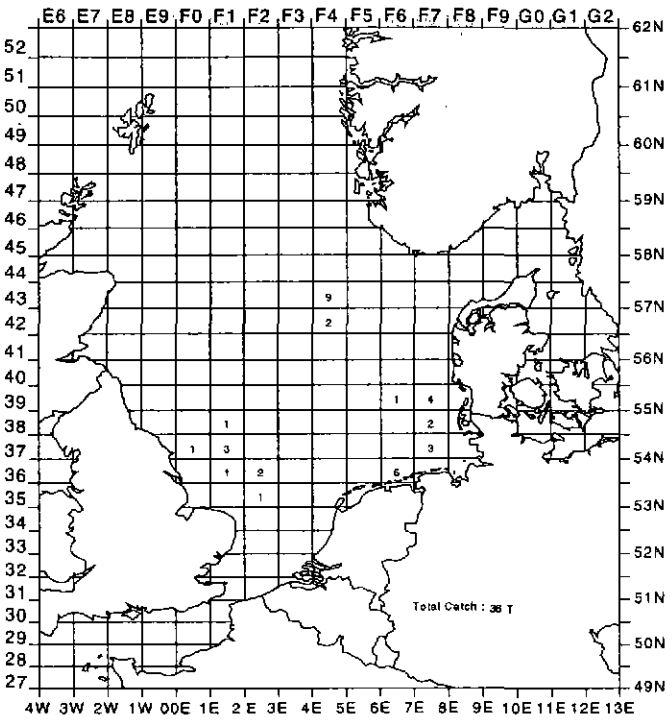


Figure 8.1.7 Sprat North Sea catches (in tonnes). July 1998

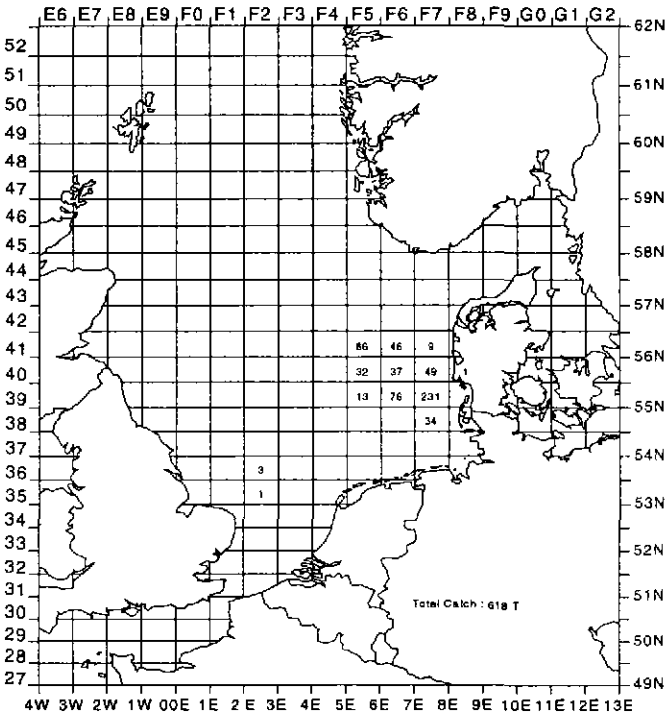


Figure 8.1.8 Sprat North Sea catches (in tonnes). August 1998

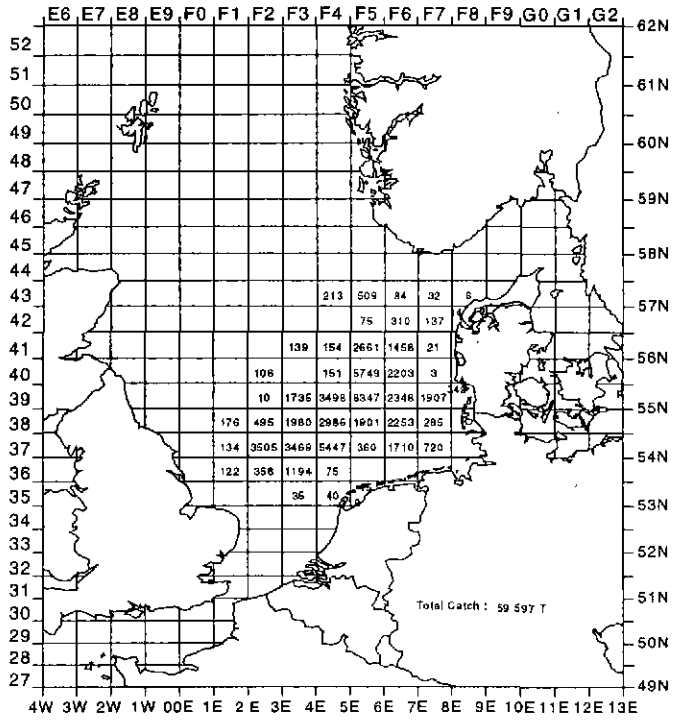


Figure 8.1.9 Sprat North Sea catches (in tonnes). September 1998

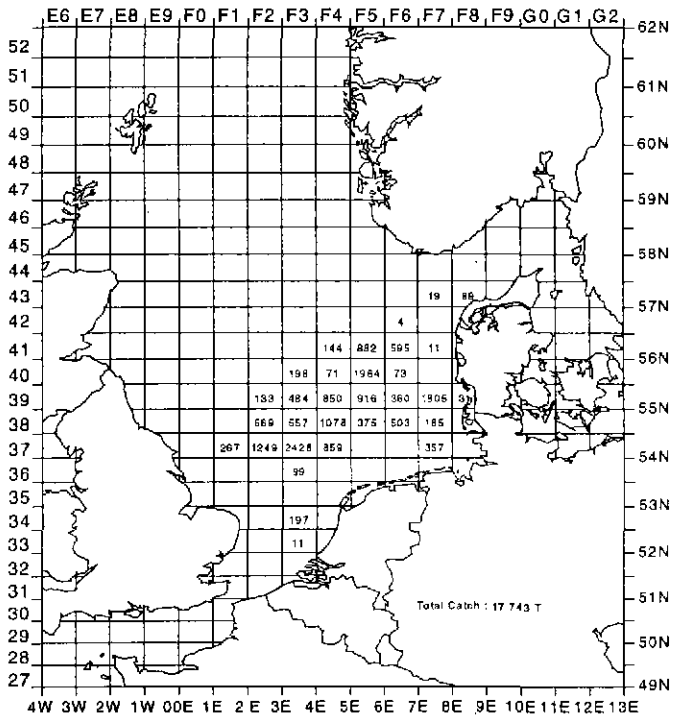


Figure 8.1.10 Sprat North Sea catches (in tonnes). October 1998

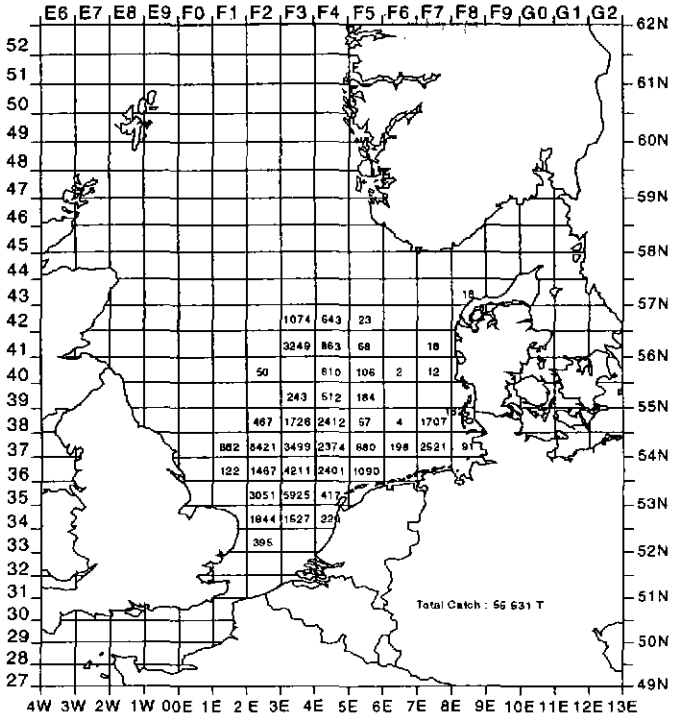


Figure 8.1.11 Sprat North Sea catches (in tonnes). November 1998

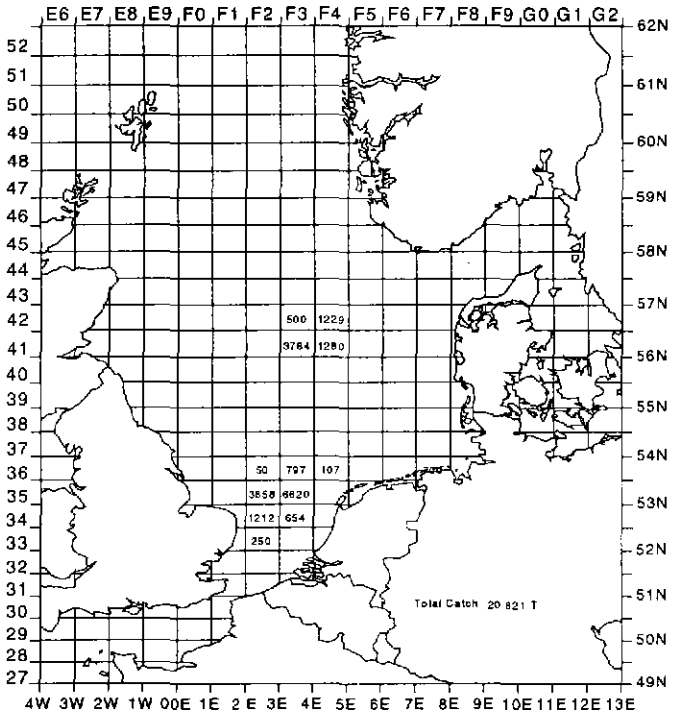


Figure 8.1.12 Sprat North Sea catches (in tonnes). December 1998

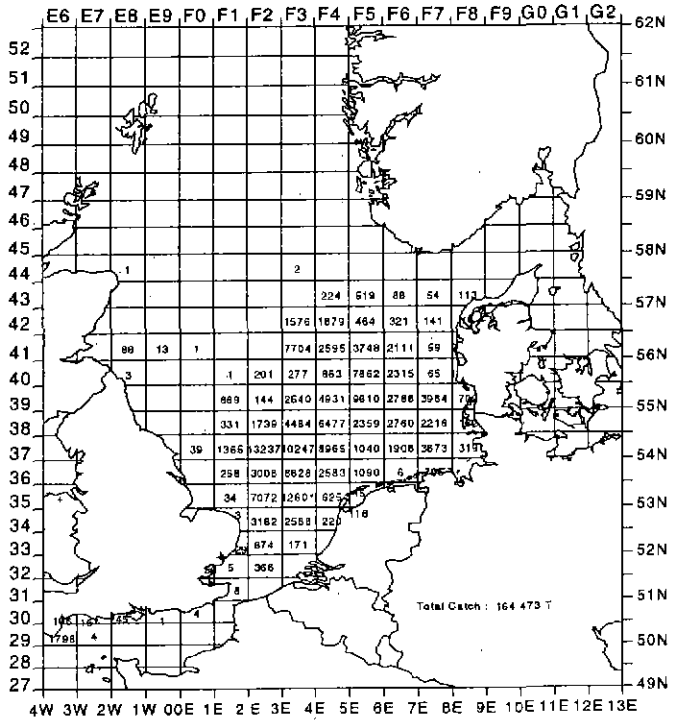


Figure 8.1.13 Sprat North Sea catches (in tonnes). Total 1998

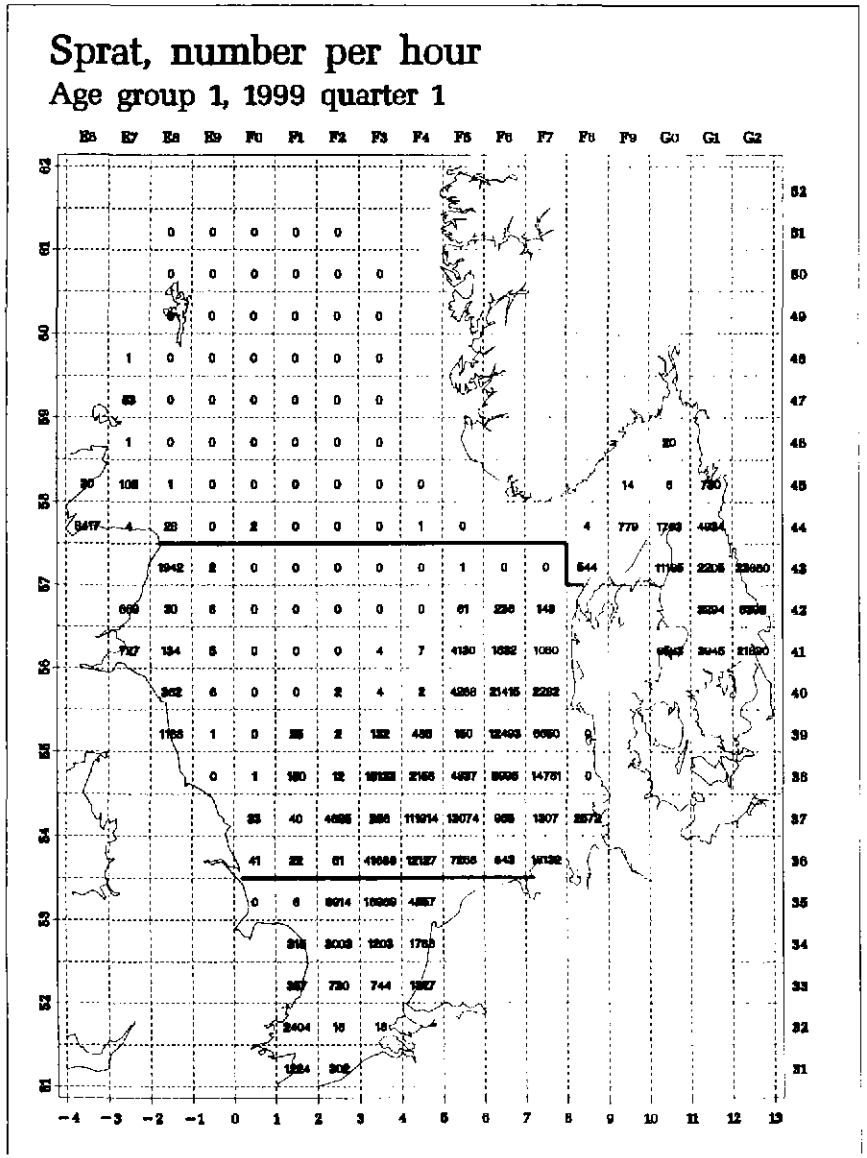


Figure 8.3.1 SPRAT. Distribution by age groups in the IBTS (February) 1999, in the North Sea and Division IIIa.

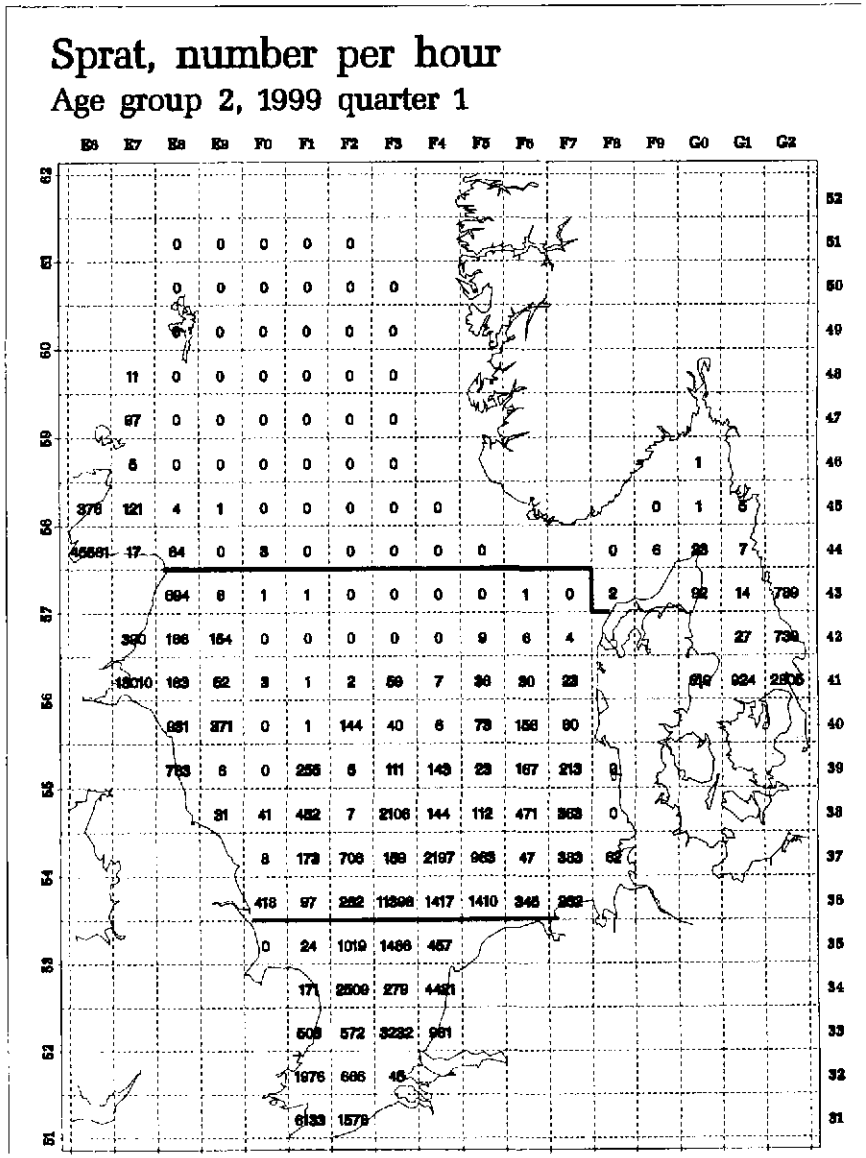


Figure 8.3.1 (Cont'd)

373

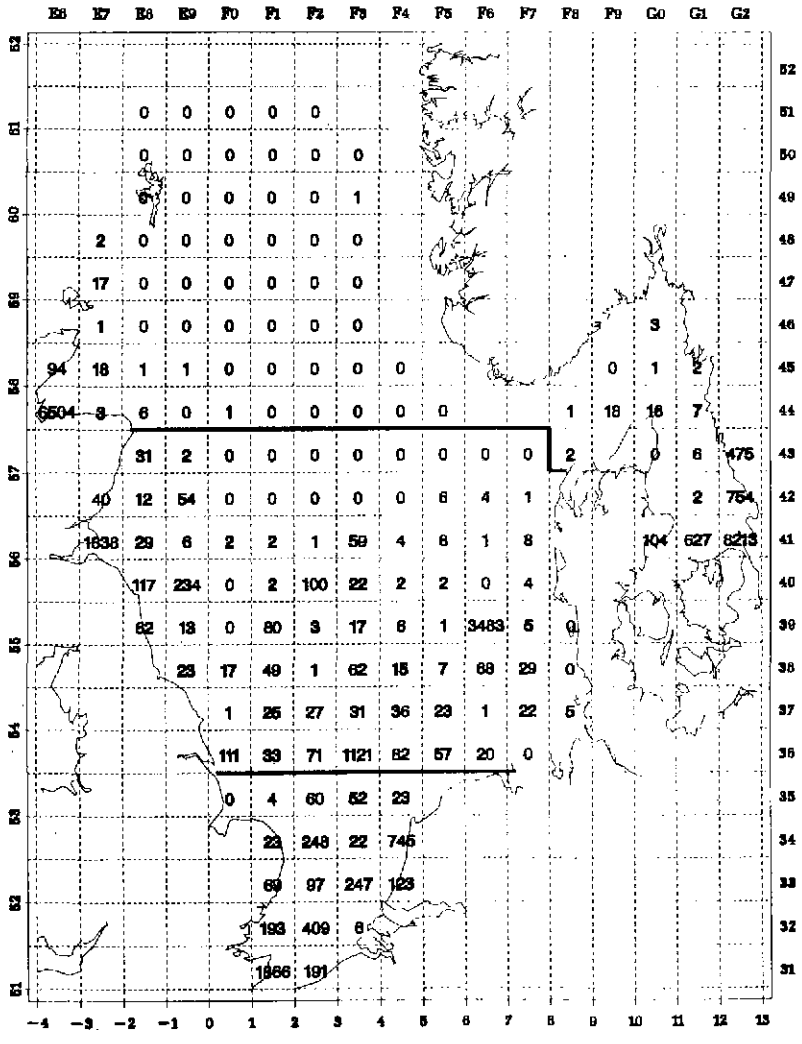


Figure 8.3.1 (Cont'd) Sprat:

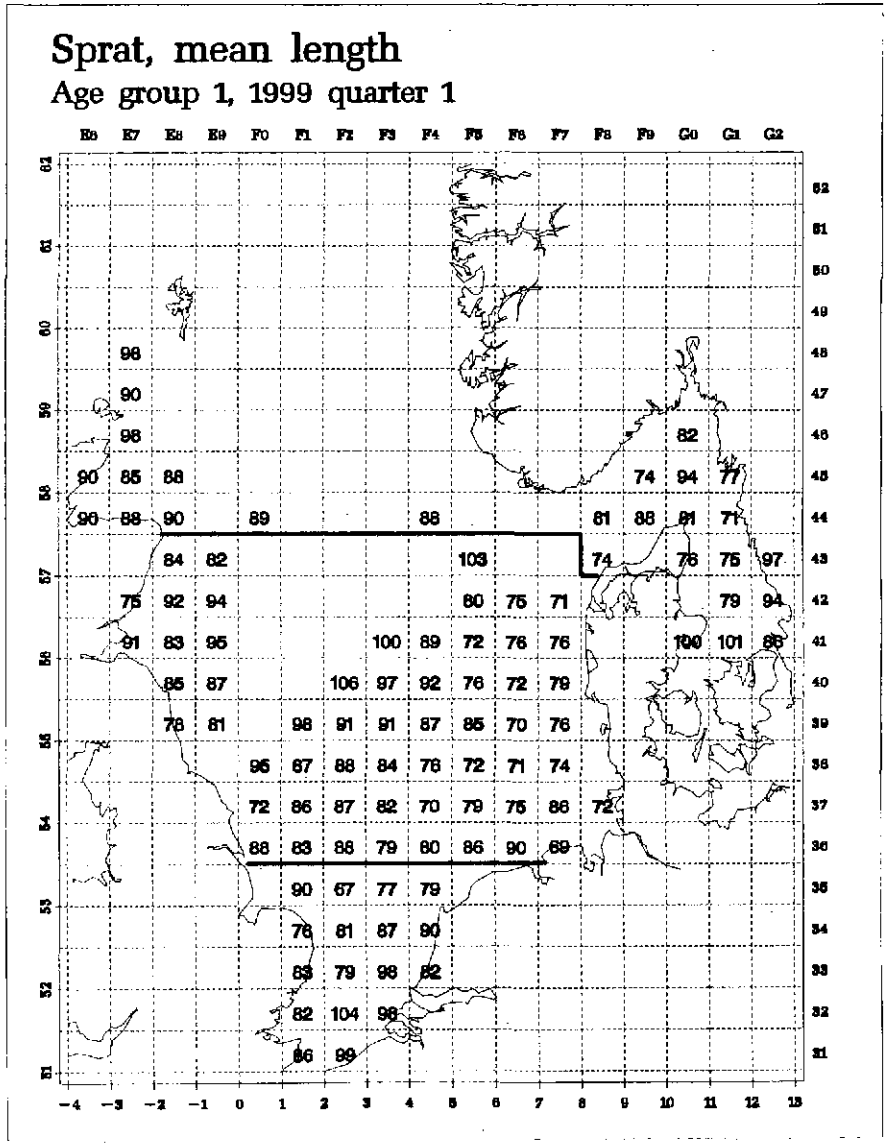


Figure 8.3.2 Mean length (mm) of age group 1 in the IBTS (February) 1999, in the North Sea and Division IIIa

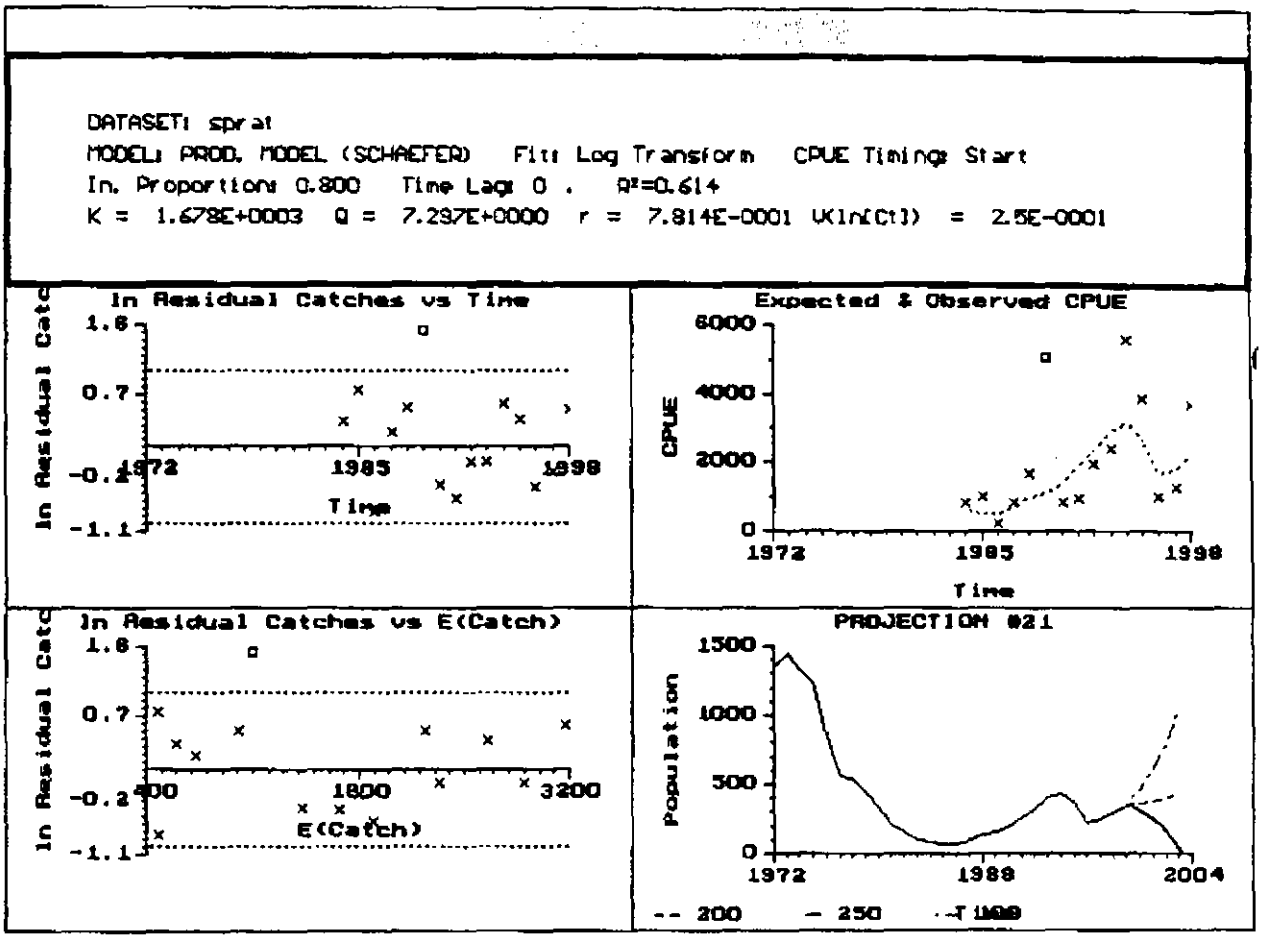
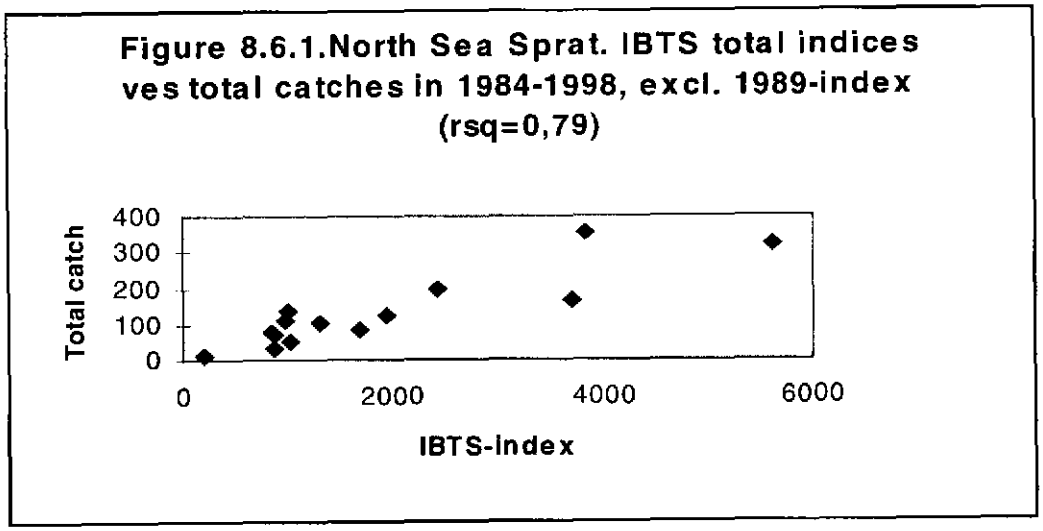


Figure 8.5.1 Schaefer production model output from CEDA program, fitted for sprat in the North Sea



9 SPRAT IN DIVISIONS VIID,E

9.1 The fishery

9.1.1 ACFM advice applicable for 1999

The TAC for this fishery was set to 12 000 t for 1997 and 1998, and to 6 300 t for 1999. No ACFM advice has been provided in recent years.

9.1.2 Catches in 1998

Table 9.1.1 shows the nominal landings in 1985–1998. The landings in 1998, as reported by UK(England&Wales), increased from 1997. The landings of 2 024 t were at the average level for the period. The landings include commercial data from English and Welsh vessels landing outside the UK and UK vessels landing into England and Wales. Monthly catches for the Lyme Bay sprat fishery show that the catches are mainly taken in third quarter (Table 9.1.2). Monthly and annual distributions of catches by rectangle are shown in Figures 8.1.1–8.1.13.

9.2 Catch Composition

Catch compositions and the mean weights for 1991–1998 are given in Table 9.2.1 and Table 9.2.2.

Commercial sample data for sprat were available for 1 quarter (Table 9.2.3). The catch composition and mean weights per age groups in the samples are used for total estimate. In the last years 2-and 3-groups sprat have dominated the landings.

Table 9.1.1. Nominal catch of sprat (t) in Divisions VIId,e,1985-1998

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997*	1998*
Denmark	-	15	250	2,529	2,092	608	-	-	-	-	-	-	-	-
France	14	-	23	2	10	-	-	35	2	1	+			-
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (Engl.&Wales)	3,771	1,163	2,441	2,944	1,319	1,508	2,567	1,790	1,798	3,177	1,515	1,789	1,621	2,024
Total	3,785	1,178	2,714	5,475	3,421	2,116	2,567	1,825	1,800	3,178	1,515	1,789	1,621	2,024

* Preliminary

Table 9.1.2 Lyme Bay sprat fishery. Monthly catches (t). (UK vessels only).

Season	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
1991/92	0	0	0	205	450	952	60	358	258	109	51	0	2443
1992/93	0	0	0	302	472	189	294	248	284	158	78	0	2025
1993/94	0	8	0	156	82	302	529	208	417	134	53	0	1889
1994/95	0	0	0	299	834	545	608	232	112	68	0	0	2698
1995/96	0	0	0	154	409	301	307	151	15	80	28	4	1449
1996/97	0	0	0	309	452	586	47	243	239	74	30	0	1980
1997/98	2	0	14	259	625	105	255	19	50	184	45	0	1558
1998/99	0	0	0	337	728	206	56	318					1645

Table 9.2.1. Lyme Bay sprat fishery. Number caught by age group (millions).

Season	0/1	1/2	2/3	3/4	4/5	5/6
1991/92	1.7	56.03	44.69	16.24	0.57	0.03
1992/93[1]	0.22	28.23	48.61	12.94	1.56	0
1993/94[2]	0	0.83	44.81	15.7	1.95	0.58
1994/95	No data					

	0	1	2	3	4	5	6
1995[3]		0.33	5.20	2.31	0.23	0.03	
1996	0.72	12.60	71.35	22.00	1.24	0.20	
1997		8.81	42.88	31.87	5.43	0.10	
1998		4.08	81.16	37.52	5.05	0.39	

[1] August to December only (samples in August and December only, so these are best estimates

[2] August to December only (samples in August, September and November only, so these are best estimates

[3] Only September (one sample)

Table 9.2.2 Lyme Bay area SPRAT. 1991–1998 mean weight (g) at age.

Season	Quarter	Age 0/1	1/2	2/3	3/4	4/5	5/6	Overall mean
1991/91	3	4.7	16.6	22.6	25.4	29.2	34.6	20.7
	4	6.6	17.1	23	26.3	30.9		21.0
	1	5.7	13.3	17.5	20.2	24.1		14.4
1992/93	3	4.2	12.1	22.8	24.6	32.4		21.8
	4		15.8	20.0	23.8	24.8		21.0
	1		13.2	17.1	21.2			14.2
1993/94	3			19.1	22.2	20.8		19.8
	4[1]		14.2	18.9	24.5	28.1	25.5	20.6

Season	Quarter	Age 0	1	2	3	4	5	6	Overall mean
1995	3[2]	-	-	12.0	17.0	19.0	21.0	29.0	-
1996	1			8.0	11.0	13.0	13.0		-
	4	8.0	15.0	19.0	23.0	28.0			-
1997	1		10.0	15.0	19.0	22.0	28.0		
	3		13.0	17.0	19.0	24.0			
	4		17.0	20.0	22.0	23.0			
1998	1		11.0	13.0	18.0	21.0	28.0		15.0

[1]Based on November samples only.

[2]Based on September sample only.

Table 9.2.3 Division VIId,e Sprat. Sampling commercial landings for biological samples in 1998.

Country	Quarter	Landings ('000 t)	No. samples	No. meas.	No. aged
1998					
England/Wales					
	1	0.3	2	326	141
	2	0.0	0	0	0
	3	1.1	0	0	0
	4	0.6	0	0	0
	Total	2.0	2	326	141

10 SPRAT IN DIVISION IIIA

10.1 The Fishery

10.1.1 ACFM advice applicable for 1998 and 1999

There has been no ACFM advice on sprat TAC in recent years. Sprat has been landed under the TAC for the mixed-clupeoid fishery, including all catches of all species taken in this fishery. The mixed-clupeoid quota was negotiated between Norway and EU in 1997.

The sprat TAC for 1998 was 40,000 t, with a restriction on by- catches of herring not exceeding 12,000 t. For 1999 the sprat TAC is set at 50,000 t and again a by-catch ceiling for TAC for herring set to 19,000 t.

10.1.2 Landings

The proportion of sprat in the mixed-clupeoid fishery increased substantially between 1993 and 1994. In 1994 and 1995 there was, for the first time in several years, a directed sprat fishery for industrial purposes in Skagerrak and the northern part of Kattegat. These high sprat catches have not occurred since.

The total annual landings for Division IIIa by area and country in 1974 to 1998 are given in Table 10.1.1. The total landings in 1998 were 18.400 t, similar to 1996 and 1997. There has been a reduction in total landings from a peak of 96,000 t in 1994. The Norwegian and Swedish landings include the coastal and fjord fisheries. These landings continued to be low.

Landings by countries and by quarter are shown in Table 10.1.2. For 1998 about 63% of the total landings were taken in the fourth quarter. In Denmark in 1998 there was a total ban on the sprat fishery from May to September.

10.1.3 Fleet

Fleets from Denmark, Norway and Sweden prosecute the sprat fishery in Division IIIa.

The Danish sprat fishery consistes of trawlers using a 16 mm mesh size.

In Sweden the sprat fishery consists of three categories:

1. By-catches in a directed herring trawl fishery with minimum mesh size of 32 mm and by purse seiners.
2. Directed sprat fishery for human consumption carried out by purse seiners.
3. A directed sprat trawl fishery with mainly 16, 18 or 22 mm mesh size, for human consumption and for reduction purposes.

The Norwegian sprat fishery in Division IIIa is an inshore purse seine fishery for human consumption.

10.2 Catch composition

10.2.1 Catches in number and weight at age

The numbers and the mean weight by age for 1995 to1998 are presented in Tables 10.2.1 and Table 10.2.2, respectively. The data for 1995 to 1997 were revised. Landings which were not attributable to specific samples were raised using Danish data from industrial landings and for the years where Swedish samples were available by a combination of Swedish and Danish samples.

10.2.2 Quality of catch and biological data

Denmark improved its monitoring system for management and scientific purposes in 1996. The high sampling level in 1996 continued in 1997 and 1998. In the reduction fishery 311 samples for species composition were collected from a total landing of 54,000 t of all species.

Denmark and Sweden provided biological samples. These were used, for estimation of numbers of sprat at age and the mean weight at age (Table 10.2.1 and Table 10.2.2). The quantity of sampling has improved and was considered adequate. As in previous years, no samples of sprat were taken from the fisheries for human consumption. Details on the sampling for biological data are shown in Table 10.2.3.

10.3 Recruitment

The IBTS(February) sprat indices for 1984–1999, are presented in Table 10.3.1. The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1,2 and 3+, and the mean length (mm) of 1-gr sprat in Figure 8.3.2. The indices are calculated as mean cpue (no./hr) weighted by area where water depths are between 10 and 150 m ((ICES 1995a).

The 1999 IBTS index of the 1-group is one of the highest recorded for the period, while the index of the 2–4 age groups appears to be in the lower part of the range. The age/length key from the IIIa-area in the 1999 IBTS-survey indicate a reasonable separation into age-groups. The total sprat index has increased from a low level in 1997 to a value near the mean for the period.

The indices from the 1998 survey confirm that the age structure of sprat from the survey is variable. The difficulties in following strong and weak cohorts from year to year have been demonstrated in previous years (ICES 1998a).

10.4 Acoustic Survey

Acoustic estimates of sprat were included in the ICES Co-ordinated Herring Acoustic surveys in 1996. In 1996 the total estimates was 7.9 x 10^8 fish or 14,267 tonnes. About 95% of the biomass was recorded in Kattegat. From the 1997 and 1998-acoustic surveys only single individuals of sprat were caught (ICES 1998d, 1999b)

10.5 State of the Stock

No assessments of the sprat stock in Division IIIa have been presented since 1985 and this year is no exception. The Biomass dynamic model was fitted using the CEDA package, see sec. 8.5.1 The data used were the total catch for 1969–1998 and the IBTS(February) abundance indices for 1984 to 1998. The absence of abundance indices for the earlier years, were given -1 as an input value proportions. As illustrated in Figure 10.5.1, the data are not usable in the model.

A depletion model with an index of recruitment model (CEDA-package) was run. The IBTS 1-group indices (1984–1999) were used as an index of recruitment and the total IBTS indices and the total catches as the additional indices. The outcome clearly demonstrated that the model did not work.

The Working Group concluded that the available data do not allow any assessment which could be helpful for management.

10.6 Projection of Catch and Stock

The relationship between the IBTS(February) index and the catch in the same year ($r^2 = 0.04$) is shown in Figure 10.6.1. The 1994 and 1995 observations are abnormally high.

The estimated landings for 1999 using the total IBTS-indices in a SHOT-estimate (Shepherd, 1991) were approximately 20,000 tonnes (Table 10.6.1). Other runs, using the 1-group indices and the combined 1-and 2-group indices, gave yields for 1999 in the range of 30–60,000 tonnes.

10.7 Management Considerations

The recruitment between years does not appear to be driven directly by fishing effort. The sprat stock has in recent years been mainly fished together with herring, except from 1994 and 1995 when a directed sprat fishery was implemented. The human consumption fishery is only a minor part of the total catch.

The natural variability in the stock is high. The current management regime with The natural variability in stock abundance is high. With the current management regime, where by-catch ceilings of herring as well as by-catch percentage limits, the sprat fishery can in periods be controlled by these factors. But, as in 1998, the main controlling factor can be the TAC limits. Protection of juvenile herring, will probably control the sprat fishery.

Attempts to assess this stock have demonstrated the need for imroved sprat sampling for age data. There is also a need for better knowledge of spawning seasons and recruitment from possible autumn spawners in the North Sea.

Table 10.1.1 Landings of SPRAT in Division IIIa, 1974–1998. Catch (in tonnes 10^{-3}). (Data provided by Working Group members). These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	Skagerrak				Kattegat			Div. IIIa total
	Denmark	Sweden	Norway	Total	Denmark	Sweden	Total	
1974	17.9	2.0	1.2	21.1	31.6	18.6	50.2	71.3
1975	15.0	2.1	1.9	19.0	60.7	20.9	81.6	100.6
1976	12.8	2.6	2.0	17.4	27.9	13.5	41.4	58.8
1977	7.1	2.2	1.2	10.5	47.1	9.8	56.9	67.4
1978	26.6	2.2	2.7	31.5	37.0	9.4	46.4	77.9
1979	33.5	8.1	1.8	43.4	45.8	6.4	52.2	95.6
1980	31.7	4.0	3.4	39.1	35.8	9.0	44.8	83.9
1981	26.4	6.3	4.6	37.3	23.0	16.0	39.0	76.3

Year	Skagerrak			Kattegat		Div. IIIa	Division IIIa Total
	Denmark	Sweden	Norway	Denmark	Sweden	Sweden	
1982	10.5	-	1.9	21.4	-	5.9	39.7
1983	3.4	-	1.9	9.1	-	13.0	26.4
1984	13.2	-	1.8	10.9	-	10.2	36.1
1985	1.3	-	2.5	4.6	-	11.3	19.7
1986	0.4	-	1.1	0.9	-	8.4	10.8
1987	1.4	-	0.4	1.4	-	11.2	14.4
1988	1.7	-	0.3	1.3	-	5.4	8.7
1989	0.9	-	1.1	3.0	-	4.8	9.8
1990	1.3	-	1.3	1.1	-	6.0	9.7
1991	4.2	-	1.0	2.2	-	6.6	14.0
1992	1.1	-	0.6	2.2	-	6.6	10.5
1993	0.6	4.7	1.3	0.8	1.7	-	9.1
1994	47.7	32.2	1.8	11.7	2.6	-	96.0
1995	29.1	9.7	0.5	11.7	4.6	-	55.6
1996	7.0	3.5	1.0	3.4	3.1	-	18.0
1997[1]	7.0	3.1	0.4	4.6	0.7	-	15.8
1998[1]	3.9	5.2	1.0	7,3	1.0	-	18.4

[1]Preliminary.

Table 10.1.2. Div. IIIa Sprat. Landings of sprat ('ooo t) by quarter by the three countries. (Data provided by the Working Group members)

Quarter		Denmark	Norway	Sweden	Total
1994	1	0.3	0.0	0.5	0.8
	2	6.0	0.0	0.3	6.3
	3	37.0	0.1	23.0	60.1
	4	16.1	1.7	11.0	28.8
Total		59.4	1.8	34.8	96.0
1995					
	1	4.8	0.1	4.8	9.7
	2	10.4	0.0	0.9	11.3
	3	19.3	0.0	2.3	21.6
	4	6.3	0.4	6.3	13.0
Total		40.8	0.5	14.3	55.6
1996					
	1	5.6	+	4.2	9.8
	2	3.4		0.2	3.6
	3	+	0.4	+	0.4
	4	1.4	0.6	2.2	4.2
Total		10.4	1.0	6.6	18.0
1997					
	1	0.7	-	0.3	1.0
	2	0.4	-	1.2	1.6
	3	2.3	-	0.1	2.4
	4	8.2	0.4	2.2	10.8
Total		11.6	0.4	3.8	15.8
1998					
	1	4.0	0.1	0.1	4.2
	2	0.9		+	0.9
	3	1.1	0.3	0.4	1.8
	4	5.4	0.7	5.7	11.7
Total		11.4	1.1	6.1	18.6

Table 10.2.1 Division IIIA Sprat. Landed numbers (millions) of sprat by age groups in 1995–1997.

	Quarter	Age						
		0	1	2	3	4	5+	Total
1995	1		312.04	784.37	53.50	27.29	9.01	1186.20
	2		1248.72	993.29	61.06	15.24	4.77	2323.08
	3		1724.02	133.56	14.17			1871.74
	4		902.76	139.95	29.95	10.58		1083.25
	Total		4187.54	2051.17	158.68	53.12	13.77	6464.27
1996	1		288.42	546.53	62.11	15.65	5.07	917.78
	2		0.89	414.10	42.76	0.71	0.06	458.51
	3		0.34	1.81	0.30	0.02		2.47
	4		31.19	165.65	27.34	2.03		226.21
	Total		320.84	1128.08	132.51	18.41	5.13	1604.97
1997	1			3.43	18.31	20.60	4.59	46.94
	2		1.00	2.76	19.56	1.51	0.25	25.07
	3	4.35	209.25	9.51	1.92	6.24		231.26
	4	32.39	644.28	58.31	7.16	28.02		770.16
	Total	36.74	854.53	74.01	46.95	56.37	4.84	1036.69
1998	1		14.91	103.38	94.00	76.99	6.34	295.61
	2		3.24	21.49	20.59	16.63	1.33	63.28
	3	53.62	26.03	41.84	5.65	0.74		127.88
	4	192.13	253.98	226.55	53.14	29.80		755.61
	Total	245.75	298.16	393.25	173.38	124.17	7.67	996.63

Table 10.2.2. Division IIIa Sprat. Quarterly mean weight (g) at age in the landings in 1995–1998.

	Quarter	Age						SOP
		0	1	2	3	4	5+	Tons
1995	1		2.3	8.9	18.8	22.9	26.1	9,519
	2		2.9	7.3	12.4	23.7	27.0	12,054
	3		10.5	18.4	15.5			20,765
	4		11.5	15.6	15.5	18.2		13,262
	Total		7.8	9.2	15.3	22.2	26.4	55,600
1996	1		9.2	10.6	14.2	17.4	17.7	9,724
	2		8.6	12.5	15.1	17.4	17.0	5,847
	3		4.2	10.9	15.5	21.0		26
	4		4.2	10.9	15.5	21.0		2,403
	Total		8.7	10.6	14.8	19.6	17.7	18,000
1997	1			17.3	18.6	21.8	26.0	968
	2		8.3	17.6	20.0	22.1	31.0	489
	3	4.1	13.6	17.2	21.1	19.5		3,184
	4	4.7	14.7	17.5	21.1	19.5		11,327
	Total	4.6	14.4	17.5	19.6	20.4	26.3	15,969
1998	1		6.6	14.0	18.0	19.0	21.2	4,827
	2		6.6	13.9	17.8	18.7	21.0	1,027
	3	4.6	17.7	20.7	22.1	24.8		1,718
	4	4.8	17.5	20.4	22.5	27.5		12,001
	Total	4.8	16.9	18.3	20.2	19.2	21.1	19,573

Table 10.2.3 Division IIIa Sprat. Sampling commercial landings for biological samples in 1997–1998.

Country	Quarter	Landings ('000 t)	No. samples	No. meas.	No. aged
1997					
Denmark					
Skagerrak	1	0.2	4	309	0
	2	0.3	4	68	0
	3	1.6	6	591	56
	4	4.9	16	1609	160
	Total	7.0	30	2,577	216
Kattegat	1	0.5	2	41	40
	2	+	1	100	46
	3	0.7	1	63	68
	4	3.3	2	256	126
	Total	4.5	6	460	280
Denmark		11.5	36	3651	496
Norway		0.4	0	0	0
Sweden		3.8	0	0	0
	Total	15.7	36	3651	496
1998					
Denmark					
Skagerrak	1	0.8	6	642	0
	2	0.7	1	3	0
	3	0.6	9	819	0
	4	1.8	23	2522	273
	Total	3.9	39	3,986	273
Kattegat	1	3.2	4	426	
	2	0.2	2	437	140
	3	0.5	2	171	82
	4	3.5	6	374	97
	Total	7.4	14	1,408	319
Sweden					
Skagerrak	1	0.1			
	2	0.0	1		
	3	0.2	3	16	16
	4	4.8	3	47	46
	Total	5.1	7	63	62
Kattegat	1	0.0	6	39	39
	2	0.0			
	3	0.1			
	4	0.9			
	Total	1.0	6	39	39
Denmark		11.3	53	5394	592
Norway		1.1	0	0	0
Sweden		6.1	13	102	101
	Total	18.5	66	5496	693

Table 10.3.1. Division IIIa Sprat. Revised indices of sprat per age group from IBTS(February) 1984-1999. (Mean number per hour per rectangle weighted by area. Only hauls taken in depths of 10–150 m are included).

Year	No Rect	No hauls	Age Group					
			1	2	3	4	5+	Total
1984	15	38	5779.73	854.30	207.60	80.09	61.47	6983.19
1985	14	38	2397.24	2395.15	368.76	128.50	49.11	5338.76
1986	15	38	664.99	1918.53	1786.59	116.20	31.91	4518.22
1987	16	38	2244.33	2501.38	2224.94	1655.66	78.69	8705.00
1988	13	38	939.91	5461.23	1519.15	2130.02	459.41	10509.72
1989	14	38	437.60	994.37	1077.13	603.41	147.86	3260.37
1990	15	38	502.83	237.76	69.90	65.65	49.04	925.18
1991	14	38	636.17	456.74	493.57	86.03	215.58	1888.09
1992	16	38	6016.26	605.99	272.13	215.45	79.26	7189.09
1993	16	38	1789.73	4623.70	996.75	218.97	260.08	7889.23
1994	16	38	1546.88	614.35	961.44	299.48	67.58	3489.73
1995	17	38	2282.92	1828.84	37.24	47.86	4.53	4201.39
1996	15	38	176.15	5800.45	794.23	135.95	228.51	7135.29
1997	16	41	200.80	409.84	1307.35	147.36	144.17	2209.52
1998	15	39	75.09	1742.73	680.95	1793.92	579.34	4872.03
1999	16	42	4273.15	363.18	269.01	47.77	345.85	5298.96

Table 10.6.1. Div.IIIa Sprat. SHOT forecast of landings in 1999 using total landings and the 1-(old)group IBTS-indices as input data.

Div.IIIa sprat — SHOT forecast spreadsheet version 6
Total index — Mars 1999

running recruitment weights

older	0.00		G-M =	0.00
central	1.00		exp(d)	1.00
younger	0.00	ex	exp(d/2)	1.00

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1984	36	6634		0.77	0.23				47		
1985	20	4792	4792	0.77	0.23	15			26		
1986	11	2584	2584	0.77	0.23	8	16	17	14		
1987	14	4746	4746	0.77	0.23	15	23	20	18		
1988	9	6401	6401	0.77	0.23	8	20	19	12	24	19
1989	10	1432	1432	0.77	0.23	10	4	5	13	6	5
1990	10	741	741	0.77	0.23	10	2	4	13	5	4
1991	14	1093	1093	0.77	0.23	15	3	5	18	6	5
1992	11	6622	6622	0.77	0.23	10	25	22	14	29	22
1993	9	6413	6413	0.77	0.23	8	21	18	12	24	18
1994	96	2161	2161	0.77	0.23	122	6	7	125	9	7
1995	56	4112	4112	0.77	0.23	44	25	41	73	53	41
1996	18	5977	5977	0.77	0.23	7	39	43	23	55	43
1997	16	611	611	0.77	0.23	15	4	7	21	9	7
1998	18	1818	1818	0.77	0.23	19	11	12	23	16	12
1999		4636	4636	0.77	0.23		29	26	0	34	26

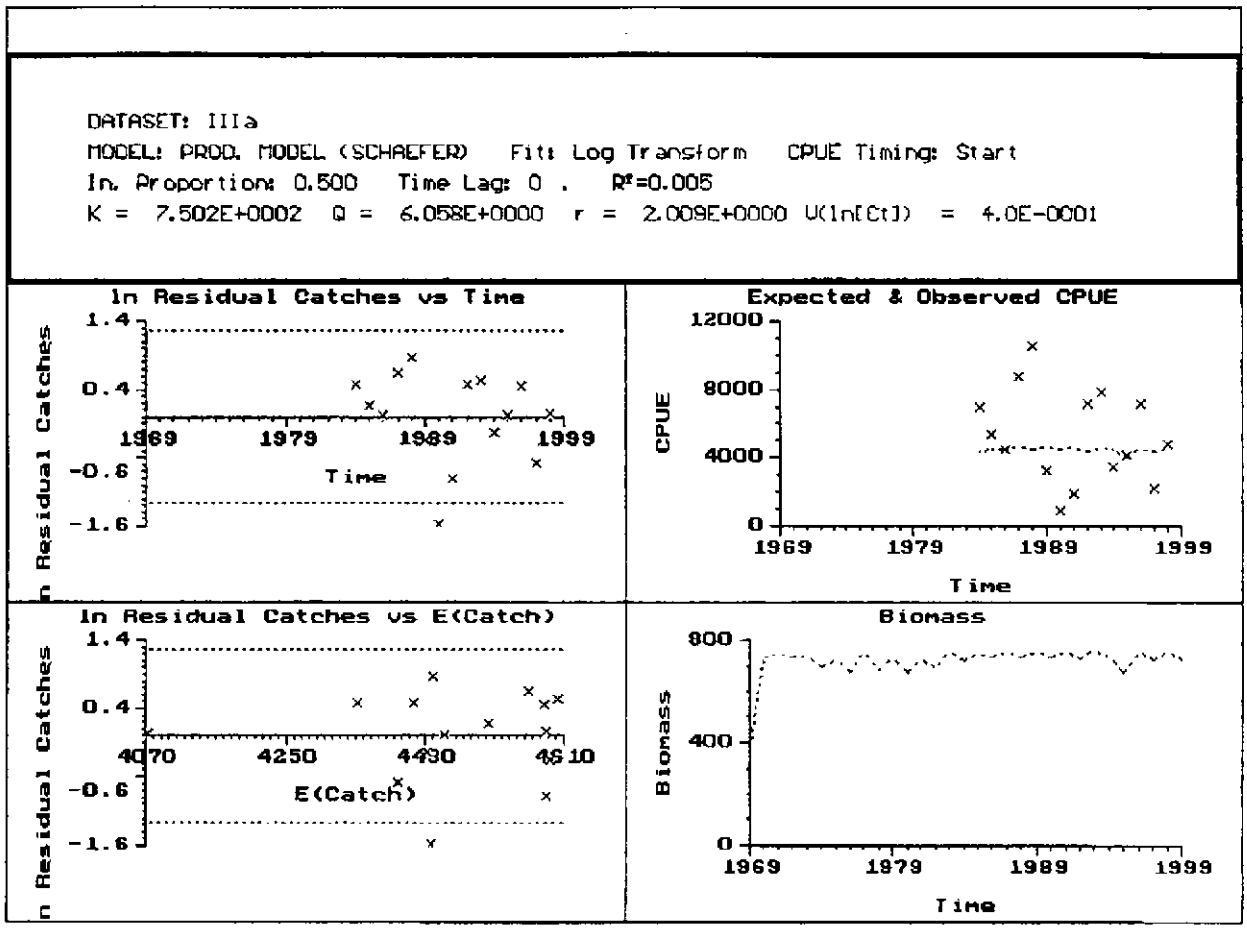
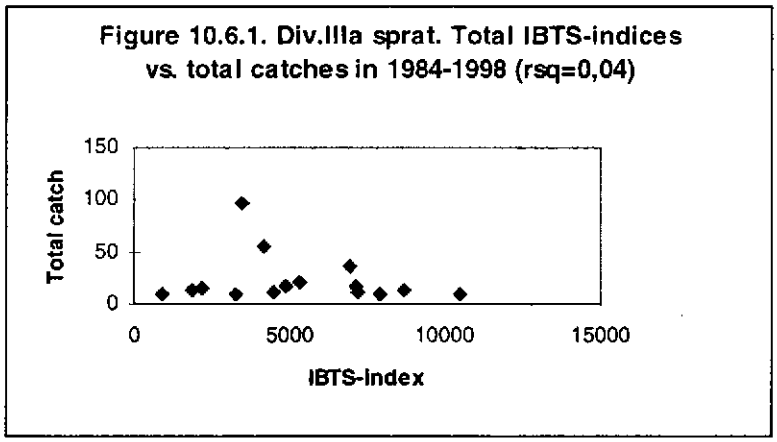


Figure 10.5.1 Schaefer production model output from CEDA program, fitted for sprat in the Division IIIa



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